This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

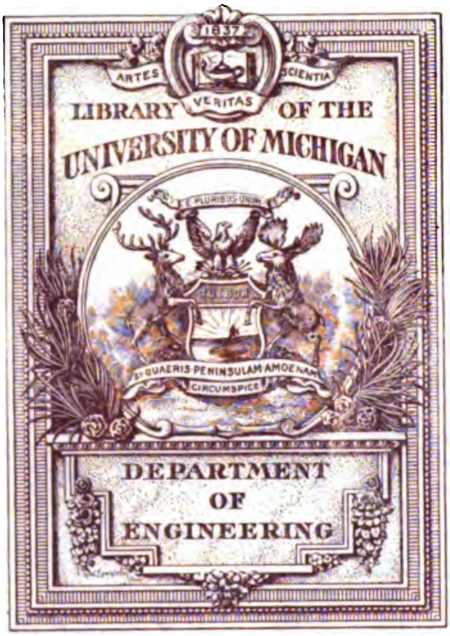
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

B 815,126



LIBRARY OF THE
UNIVERSITY OF MICHIGAN

DEPARTMENT
OF
ENGINEERING

THE GIFT OF
The Publisher.

UF [redacted]
1
.C6

LIBRARY OF THE
UNIVERSITY OF MICHIGAN

DEPARTMENT
OF
ENGINEERING

THE GIFT OF
The Publisher.

UF
1
.C6

JOURNAL OF THE UNITED STATES ARTILLERY

PUBLISHED UNDER SUPERVISION OF THE SCHOOL BOARD
OF THE COAST ARTILLERY SCHOOL

VOLUME 35
1911

FORT MONROE, VIRGINIA
COAST ARTILLERY SCHOOL PRESS
1911

COPYRIGHT.

JOURNAL OF THE UNITED STATES ARTILLERY

1911

m.

CONTENTS BY NUMBERS

No. 1

THE GERMAN HIGH-SEA FLEET .... *Frontispiece*

THE SELECTION AND DEFENSE OF NAVAL BASES 1
By Colonel Martin,—an ex-Confederate Officer

INVESTIGATION OF GASOLENE ENGINES WITH A VIEW TO DETERMINING THEIR SUITABILITY AS A SOURCE OF POWER FOR COAST DEFENSE INSTALLATIONS 32
By Captains John O. Steger and Frank T. Hines, C. A. C.

RANGE CORRECTIONS FROM OBSERVATION OF FIRE 57
By "Observer"

PROFESSIONAL NOTES:
- The Stiffness of Guns 63
- Submarine Cable-Laying and Repairing 75
- Effects on Coast Defense of the Naval Developments of the Last Few Years 83, 86
- Naval and Military Progress in 1910 92
- The Ram Bow 94
- Warship Armaments 95
- A New Method of Measuring the Strength of Magnetic Fields 96
- Explosion Gases and Their Effects on Man 99
- Some Remarks on Wet Guncotton 101

SHORT NOTES: 102

Main Battery Arrangement of the Orion—Englands Latest Battleship Cruiser—First Italian Deadnought—Italian Dreadnoughts—Stowage of Battleship Boats—The British Neptune—German Naval Items—The Next Dreadnought—Naval Gunnery—Disposing Gun Turrets—British Dreadnought with 13.5-inch Guns—Fire Control Stations in German Ships—Japanese Battleship to be Built at Barrow—New French Torpedo—Gyroscope for Firing a Wayward Torpedo—Germany Has New Gun—Universal Projectiles—Fortifying Port of Salina Cruz—The Dutch Fortifications—Copper *versus* Aluminum for Conductors—Brittleness of Tungsten Lamp Filament Overcome—Economy Possible Due to Power Gas—Nothing Alcoholic on Canadian Ships.

CORRESPONDENCE: 110

Probable Error of Guns in Figure of Merit—The Composite Artillery Type Telephone—Amendments to Reminder Lists—F. C. System Tests Shown Graphically—Night Shore Signals to Tug.

251000

BOOK REVIEWS: 115

Military Topography for the Mobile Forces—Cavalry Tactics as Illustrated by the War of the Rebellion Together with Many Interesting Facts Important for Cavalry to Know—Strong Vincent and His Brigade at Gettysburg, July 2, 1863—A Manua lfor Aspirants for Commissions in the United States Service.

NOTICES: 118

No. 2

H. M. TURBINE-CRUISER "VON DER TANN" .... *Frontispiece*

MORE ON THE SELECTION OF NAVAL BASES 119
By "Amphibious"

INVESTIGATION OF GASOLENE ENGINES WITH A VIEW TO DETERMINING THEIR SUITABILITY AS A SOURCE OF POWER FOR COAST DEFENSE INSTALLATIONS (Concluded) 125
By Captains John O. Steger and Frank T. Hines, C. A. C.

INSTRUCTION OF COAST ARTILLERY CORPS, RHODE ISLAND NATIONAL GUARD 155
By Captain Arthur P. S. Hyde, Coast Artillery Corps

COMPARATIVE COAL TESTS 167
By 1st Lieutenant Offnere Hope, Coast Artillery Corps

PROFESSIONAL NOTES:
- Vickers' Ordnance at the Japan-British Exhibition 182
- Four Recent Types of Dreadnoughts 190
- Erosion and Ballistics: A Rejoinder 203
- Cause of Gun Accidents 209
- Shooting in the British Navy 210
- Experiments with Guns *versus* Armor (The Katahdin) 213
- Fortification or Neutralization (of the Panama Canal) 214
- Effects on Coast Defense of Naval Developments of the Last Few Years 217, 221, 225
- The Laurenti Submersible 227
- Artificial Respiration 230
- Launch of the Japanese Battleship "Kawachi" 233

SHORT NOTES: 233

The Lake Submarines—Wireless Telegraphy on Submarines—Results of French Battle Practice—New French Torpedo—Maps for Aeronauts.

NOTICES: 235

A European Party at Very Reasonable Cost—The American Society of Mechanical Engineers—Moro Province Fair —Smithsonian Institution Report, 1909.

CORRESPONDENCE: 238

Description of a Deflection Correction Device.

BOOK REVIEWS: 240
The Campaign of Chancellorsville—Engineering Abstracts—Nautisch-technisches Wörterbuch, Vol. II, Part 2 (L to Z)—Mountain and Colonial Artillery—The Battle of the Wilderness—Taschenbuch der Kriegsflotten, 1911.

No. 3

H. M. S. NEPTUNE .... *Frontispiece*
THE ORGANIZATION AND TRAINING OF COAST ARTILLERY TROOPS, INCLUDING RESERVES AND SUPPORTS, WHICH WILL INSURE THEIR MAXIMUM EFFICIENCY IN TIME OF WAR, AFTER THEIR WITHDRAWAL FROM THE COAST FORTIFICATIONS 247
By 2nd Lieutenant Frank S. Clark, Coast Artillery Corps
THE RECRUITMENT OF OFFICERS 262
By 1st Lieutenant Thomas M. Spaulding, Coast Artillery Corps
ANALYSIS OF TARGET PRACTICE REPORTS 271
By Major Goerge F. Landers, Coast Artillery Corps
IT PAYS TO ADVERTISE 279
By "Helm"
DEFLECTION CORRECTIONS FOR SECONDARY ARMAMENT 288
By Captain Robert E. Wyllie, Coast Artillery Corps
A SIMPLE METHOD OF INDICATING AND IDENTIFYING TARGETS 292
By Captain Harold E. Cloke, Coast Artillery Corps
PROFESSIONAL NOTES:
The Erosion of Gun Tubes and Heat Phenoemna in the Bore of a Gun 296
The Type of Gun for Coast Defense 306
Guns or Howitzers 309
The Type of Weapon for Coast Armaments 310
New Empirical Formulæ for Interior Ballistics 312
The Defense of the Land Front of a Coast Fortress, with Particular Reference to the Method of Utilizing the Mobile Guns Allotted to General Defense 315
New Harbor Obstructions at Toulon 326
The "Perfect Loophole" 327
Modern Military Rifles 328
Should the Panama Canal be Fortified? 332
Canals in the Service of Coast Defense 333
The Bosporus Defenses 337
The German Coast Forts 338
The Puritan Experiment 340
The Resuscitation of Secondary Armaments 341
French Battleships 344
The Power and Protection of Battleships 347
New Feats in Aviation 349
Lubricant Characteristics 350

CONTENTS BY NUMBERS

SHORT NOTES: 353

French Target Practice—The Neptune Experiment—Protecting Anti-Torpedo Armament—H. M. S. Monarch—New Method of Welding Armor Plate—The 15-inch Gun (British)—The Austro-Hungarian Dreadnoughts—The Progress of War Material in 1910 (Field Artillery)—Two New Field Howitzers—Heavy Field Guns in Austria—Schwarzlose Machine Gun Adopted in Holland—Army Ordnance Answers English Critics—Russian Coast Defenses—Improving the Quality of Thermit Steel—French Service Uniform—Inauguration of the Railophone—Tungsten-Coated Silver Lamp Filament—Wireless Telegraphy—Events of Military Interest in Germany During the Month of January, 1911—The Collapse of a Fort—Telephotography.

NOTICES: 361

American Red Cross (International Conference)—Congress of Technology—The Field Artillery Journal—Ehrhardt War Materiel—Mountain and Colonial Artillery—Railway Statistics of the United States of America—Nautical Technical Dictionary.

CORRESPONDENCE: 364

Recruitment of Officers—Notes and Tables from C. A. R. D.—Rhode Island Coast Artillery Reserves—Manual for Ordnance Officers.

BOOK REVIEWS: 373

Tactics. Vol. I. Introduction and Formal Tactics of Infantry—Bone and Hoof Diseases of the Horse.

INDEX TO VOLUME 35

JANUARY-JUNE, 1911

I. Authors.

Alger, P. R. Erosion and Ballistics—A Rejoinder (Reprint)...... 203
"*Amphibious*". More on the Selection and Defense of Naval Bases 119
Barberis, L. Four Recent Types of Dreadnoughts (Reprint)..... 190
Behr, F. J. Bone and Hoof Diseases of the Horse (Review)...... 374
Behr, F. J. Mountain and Colonial Artillery (Review).......... 244
Behr, F. J. Nautisch-technisches Worterbuch, Vol. II, Part 2 (Review) 243
Behr, F. J. Taschenbuch der Kriegsflotten, 1911 (Review)...... 246
"*Bellfield*". Effects on Coast Defense of Naval Developments of the Last Few Years (Reprint).......... 217
Bender, L. B. Composite Artillery Type Telephone............ 111
Bright, C. Submarine Cable-Laying and Repairing (Reprint).... 75
Brown, H. S. Notes and Tables from C. A. D. R............... 365
Buckle, C. R. Effects on Coast Defense of the Naval Developments of the Last Few Years (Reprint).......... 86
Buttgenbach, W. J. Probable Error of Guns in Figure of Merit.... 111
Canfield, E., Jr. F. C. System Tests Shown Graphically........ 112
Carmichael, R. L. Night Shore Signals to Tug................ 114
Clark, F. S. The Organization and Training of Coast Artillery Troops, Including Reserves and Supports, which will Insure Their Maximum Efficiency in Time of War, After Their Withdrawal from the Coast Fortifications. (Prize Essay, 1910) 247
Cloke, H. E. A Simple Method of Indicating and Identifying Targets 292
Coast Artillery Board. Description of a Deflection Correction Device 238
Corput, R. Van D. Canals in the Service of Coast Defense (Trans.) 333
Coward, J. M. Military Topography for the Mobile Forces (Review) 115
Davis, M. F. Cavalry Tactics as Illustrated by the War of the Rebellion, Part I (Review).......... 116
Davis, W. C. Tactics. Vol. I. Introduction and Formal Tactics of Infantry (Review) 373
Ellis, W. E. Amendments to Reminder Lists................. 112
Greig, P. S. The "Perfect" Loophole (Reprint)............... 327
Hall, H. Range Corrections from Observations of Fire........ 57
Harrison, A. E. Guns or Howitzers (Reprint) 309
Harrison, A. E. The Type of Gun for Coast Defense (Reprint).. 306

INDEX

Harrison, A. E. The Type of Weapon for Coast Armaments (Reprint) 310
"*Helm*". It Pays to Advertise 279
Hines, F. T. Investigation of Gasolene Engines With a View to Determining Their Suitability as a Source of Power for Coast Defense Installations 32, 125
Hislam, P. A. Warship Armaments (Reprint) 95
Hope, O. Comparative Coal Tests 167
Hyde, A. P. S. Instruction of Coast Artillery Corps, Rhode Island National Guard 155
Ireland, M. L. Manual for Ordnance Officers 370
Jones, H. J. The Erosion of Gun Tubes and Heat Phenomena in the Bore of a Gun (Reprint) 296
Jones, H. J. Stiffness of Guns (Reprint) 63
Landers, G. F. Analysis of Target Practice Reports 271
Lauffer, C. A. Artificial Respiration. Prone Pressure Method of Resuscitation from Electric Shocks and Drowning (Reprint) 230
Martin, Colonel. Selection and Defense of Naval Bases 1
Matthews, H. T. A Manual for Aspirants for Commission in the United States Service (Review) 117
McClintock, R. L. Some Remarks on Wet Gun Cotton (Reprint) 101
Morse, H. L. It Pays to Advertise 279
"*Observer*". Range Corrections from Observations of Fire 57
Peukert, W. A New Method of Measuring the Strength of Magnetic Fields (Reprint) 96
Phillips, H. de T. The Defense of the Land Front of a Coast Fortress, With Particular Reference to the Method of Utilising the Mobile Guns Allotted to General Defense (Reprint) 315
Ragsdale, E. J. W. The Ram Bow (Trans.) 94
"*Rehabilitate*". Effects on Coast Defense of the Naval Developments of the Last Few Years (Reprint) 83, 225
Saidler, T. W. Effects on Coast Defense of the Naval Developments of the Last Few Years (Reprint) 221
Scott, W. R. The Battle of the Wilderness (Review) 244
Scott, W. R. Strong Vincent and His Brigade at Gettysburg, July 2, 1863 (Review) 117
Spaulding, T. M. The Recruitment of Officers 262, 364
Steger, J. O. Investigation of Gasolene Engines With a View to Determining Their Suitability as a Source of Power for Coast Defense Installations 32, 125
Taylor, G. A. Rhode Island Coast Artillery Reserves 369
Vestal, S. C. Selection and Defense of Naval Bases 1
Wieczorek, G. A. New Empirical Formulae for Interior Ballistics (Trans.) 312
Winston, T. W. The Campaign of Chancellorsville. A Strategic and Tactical Study (Review) 240
Winston, T. W. Engineering Abstracts (Review) 242
Wyllie, R. E. Deflection Corrections for Secondary Armament 288
Wyllie, R. E. More on the Selection and Defense of Naval Bases 119

INDEX

II. Subjects.

Advertising the army 279
Aeronauts, maps for 235
Aluminum *versus* copper for conductors 108
American Red Cross—International Conference 361
Analysis of target practice reports 271
Anti-torpedo armament, protecting 354
Armament:
  anti-torpedo, protecting 354
  coast, type of weapon for 306, 309, 310
  of *Orion*, main battery 102
  of warships 95
  secondary, deflection corrections for 288
  secondary, resuscitation of 341
Armor plate, new method of welding 355
Armor *versus* guns (the *Katahdin*), experiments with 213
Artificial respiration, prone pressure method of 230
Artillery:
  coast, organization and training 247
  coast, Rhode Island National Guard 155, 369
  field, progress of material in 1910 357
  type telephone, composite 111
Austria-Hungary:
  battleship *Viribus Unitis* 356
  heavy field guns 357
Automatic rifles 331
Aviation, new feats in 349
Ballistics:
  and erosion 203
  interior, new empirical formulæ for 312
Bases, naval, selection and defense of 1, 119
Battleships:
  French 344
  Kawachi, launch of 233
  protection and power of 347
  Monarch 355
  Sebastopol, *Wyoming*, *Jean Bart* and *Rivadavia* compared 190
  Viribus Units 536
Battle target practice, naval, French, 1910 .... 234, 353
Board, correction, mortar, deflection errors 61
Boats, stowage of on battleships 104
Bore of a gun, heat phenomena and erosion of tube 296
Bosporus defenses 337
Bow, ram 92
Cable-laying and repairing, jointing and splicing, submarine 75
Canada, nothing alcoholic on naval vessels 109
Canals:
  in the service of coast defense 333
  Panama, fortification or neutralization 214, 332
Coal tests, comparative 167
Coast Artillery Corps of Rhode Island 155, 369

INDEX

Coast Artillery troops, organization and training . . . 247
Coast Artillery Drill Regulations, notes and tables compiled from 365
Coast Defense:
  canals in the service of . . . 333
  effects on, naval developments of last few years . . 83, 86, 217, 221, 225
  guns or howitzers for . . . 309
  installations, gasolene engines for . . . 32, 125
  type of gun for . . . 306, 309, 310
Coast defenses of Germany . . . 338
Coast defenses of Russia . . . 358
Coast fortress, defense of the land front . . . 315
Comparative coal tests . . . 167
Composite artillery type telephone . . . 111
Conductors, copper *versus* aluminum . . . 108
Congress of Technology . . . 362
Copper *versus* aluminum for conductors . . . 108
Correction board, mortar, for deflection errors . . . 61
Correction device, deflection . . . 238
Corrections, deflection, for secondary armament . . . 288
Corrections, range, from observation of fire . . . 57
Dante Alighieri, Italian battleship, dimensions and armament of . . 103
Defense:
  coast, canals in the service of . . . 333
  coast, effects on, naval developments of the last few years . . . 83, 86, 217, 221, 225
  coast, gasolene engines for . . . 32, 125
  coast, type of gun for . . . 306, 309, 310
  of naval bases, selection and defense of . . . 1, 119
  of the land front of a coast fortress . . . 315
Defenses:
  Bosporus . . . 337
  Russian coast . . . 358
Deflection correction board for mortars (deflection errors) . . . 61
Deflection correction device, guns . . . 238
Deflection corrections for secondary armament . . . 288
Dreadnoughts, comparison of the four recent types . . . 190
Drill regulations, Coast Artillery, notes and tables compiled from 365
Drowning, prone pressure method of artificial respiration . . . 230
Dutch fortification, proposed . . . 108
Ehrhardt war materiel . . . 362
Electric shocks, prone pressure method of artificial respiration . . . 230
Empirical formulæ (new) for interior ballistics . . . 312
Engines, gasolene, source of power for coast defense installations 32, 125
England:
  15-inch gun . . . 356
  Indefatigable, comparison with *Invincible* . . . 103
  Neptune, top hamper, notes on . . . 104
  shooting in the navy . . . 210
  13.5-inch guns on latest dreadnought. Effect on other navies 105
Entrenchment, field, the perfect loophole . . . 327

INDEX

Erosion:
- and ballistics 203
- causes of 302
- of gun tubes and heat phenomena in the bore of a gun 296

Error (probable) of guns in figure of merit 111
European party at very reasonable cost 235
Explosion gases and their effects on man 99
Fair, Moro Province 236
Field Artillery:
- Journal 362
- heavy, Austria 357
- material, progress of in 1910 357
- gun, 75-mm., Vickers 183

Field howitzers, new one for Germany 357
Fields, magnetic, measuring strength of 96
15-inch gun, British 356
Figure of merit, probable error of guns 111
Fire control stations in German warships 105
F. C. system tests shown graphically 112
Fire, observation of, range corrections from 57
Formulæ for interior ballistics, new empirical 312
Fort, collapse of 360
Fortress, coast, defense of the land front 315
Forts, coast, of Germany 338
14-inch gun, German activity in gun factories 104
France:
- battleships 344
- naval battle target practice for 1910, results 234, 353
- new torpedo 106, 235
- service uniform, new 359

Gases, explosion, effects on man 99
Gasolene engines, source of power for coast defense installations .. 32, 125
Germany:
- coast forts 338
- events of military interest during the month of January, 1911 360
- fire control stations in warships, new location 105
- 14-inch naval gun 104
- High-Sea Fleet (Illustration, Frontispiece, Jan.-Feb., 1911), opposite 1
- naval target practice for 1910 104
- new rapid fire gun 106
- *Ostfriesland.* Note on displacement and cost 104

Graphic method of showing F. C. system tests 112
Graphite as a lubricant 353
Guncotton, wet, remarks on 101
Guns:
- causes of accidents 209
- effect of temperature strain on the straightness of 72
- erosion of tubes 296
- field, heavy, Austria 357
- field, 75-mm., Vickers 183
- 15-inch (British) 356

Guns:
  machine, Schwarzlose, adopted in Holland 358
  mobile, use of in the defense of the land front of a coast fortress 315
  naval, 12-inch 50-caliber, Vickers 185
  new one for Germany, principle of machine gun applied to rapid firers 107
  probable error in figure of merit 111
  secondary armament, resuscitation 341
  stiffness of 63
  theory of bending 65
  tests, firing smokeless powder at temperatures up to 208° F. 358
  turrets, twin and triple 105
  type for coast defense 306, 309, 310
  versus armor, experiments with (the *Katahdin*) 213
  vibration of 73
Gyroscope for firing a wayward torpedo 106
Harbor obstructions at Toulon 326
Heat phenomena in the bore of a gun and erosion of tubes 296
Holland, Schwarzlose machine gun adopted 358
Howitzers:
  field, new one for Germany 357
  4.33-inch, Vickers' 184
  or guns for coast defense 309
  6-inch siege, English, (illustration), opposite 213
Hvalen, Swedish submersible (illustration), opposite 228
Identifying and indicating targets 292
Indefatigable, English battleship-cruiser, comparison with *Invincible* 103
Indicating and identifying targets 292
Infantryman's perfect loophole 327
Installations, coast defense, power for, gasolene engines 32, 125
Instruction of Coast Artillery Corps, Rhode Island National Guard 155
Interior ballistics, new empirical formulæ for 312
Italy: Battleship *Dante Alighieri*, dimensions of 108
Japan:
  -British exhibition, Vickers' ordnance at 182
  launch of the battleship *Kawachi* 233
  new battleship to be built in England 106
Jean Bart (French battleship) compared with *Rivadavia*, *Wyoming* and *Sebastopol* 190
Journal, Field Artillery 362
Katahdin experiments of guns and armor 213
Kawachi, Japanese battleship, launch of 233
Lake submarines, features of the *Seal* 238
Land front, defense of, coast fortress 315
Laurenti submersibles 227
Lists, reminder, for service target practice 112
Loophole, the "perfect" 327
Lubricant characteristics 350
Machine gun, Schwarzlose, adopted in Holland 358
Magnetic fields, measuring strength of 96

INDEX

Manual for ordnance officers 370
Maps for aeronauts 235
Measuring the strength of magnetic fields 96
Merchant marine of Germany 339
Military and naval progress in 1910 92
Military rifles, modern 328
Mobile guns, use of in defense of a coast fortress 315
Modern military rifles 328
Monarch, British battleship 355
Moro Province Fair 236
Mortar correction board for deflection errors 61
Mountain and Colonial Artillery 363
Natal, British cruiser, (illustration), opposite 212
Nautical Technical Dictionary 363
Naval:
    and military progress in 1910 92
    bases, selection and defense of 1, 119
    developments of the last few years, effects on coast defense 83, 86, 217, 221, 225
    gun, 12-inch 50-caliber, Vickers 185
    target practice, battle, 1910, French 234, 353
    target practice, British 210
Neptune:
    experiment, British battleship control station 354
    illustration, British battleship, (Frontispiece, May-June), opposite 247
    top hamper, notes on 104
Night shore signals to tug 114
Notes and tables from C. A. D. R. 365
Observation of fire, range corrections from 57
Obstructions, harbor, at Toulon 326
Officers, ordnance, manual for 370
Officers, recruitment of 262, 364
Orders regulating wearing of uniform, advertising the army 279
Ordnance officers, manual for 370
Ordnance, Vickers', at the Japan-British Exhibition 182
Organization and training of coast artillery troops, including reserves and supports 247
Orion, main battery armament of 102
Ostfriesland, German battleship, displacement and cost 104
Panama Canal, fortification or neutralization 214, 332
Powder tests, firing smokeless up to 208° F. 358
Power and protection of battleships 347
Power gas, economy in fuel due to 109
Practice, service, reminder lists, amendments to 112
Probable error of guns in figure of merit 111
Projectiles, universal 107
Projectiles, initial unsteadiness of 63
Protecting anti-torpedo armament 354
Protection and power of battleships 347
Puritan experiment 340

INDEX

Railophone, inauguration of 360
Railroads of Germany 389
Railway statistics of the U. S. 368
Ram bow 94
Range correction from observation of fire 58
Range rod, observation of fire 57
Recruitment of officers 262, 364
Reminder lists, amendments to 112
Repairs to cables, submarine 75
Reports, target practice, analysis of 271
Reserves, Coast Artillery Corps, organization and training 247
Reserves, Coast Artillery, Rhode Island National Guard 155, 369
Respiration, artificial, prode pressure method 230
Resuscitation from electric shocks and drowning, prone pressure method 230
Resuscitation of secondary armaments 341
Rhode Island National Guard, Coast Artillery, instruction of 155, 369
Rifles, modern military 329
Rivadavia (Argentine battleship) compared with *Jean Bart*, *Wyoming* and *Sebastopol* 190
Rod, range, observation of fire 58
Roster of troops, District of New London 118
Russian coast defenses 358
Salina Cruz, fortifying of 108
Schwarzlose machine gun adopted in Holland 358
Seal, Lake submarine, distinctive features of 233
Sebastopol (Russian battleship) compared with *Wyoming*, *Jean Bart* and *Rivadavia* 190
Secondary armament, deflection corrections for 288
Secondary armament, resuscitation of 341
Selection and defense of naval bases 1, 119
Signals to tug from shore (night) 114
Smithsonian Institution Report for 1909 286
Smokeless powder tests, firing at temperatures up to 208° F. 358
Steel, Thermit, improving the quality of 359
Stiffness of guns 63
Stowage of battleship boats 104
Strength of magnetic fields, measuring of 96
Submarine cable-laying and repairing 75
Submarines:
    Hvalen (Swedish) illustration, opposite 228
    Laurenti class 227
    Seal (Lake), distinctive features of 233
    wireless telegraphy on 234
Supports, Coast Artillery, organization and training 247
Sweden: Submersible *Hvalen*, illustration, opposite 228
Tables and notes from C. A. D. R. 365
Target practice:
    British navy, Years 1907-08-09-10 211
    French navy, 1910, results 234, 358
    German navy, 1910 104
    reports, analysis of 271

Targets, indicating and identifying 292
Thermit steel, improving the quality 359
13.5-inch gun on British dreadnought—effect on other navies.... 105
Telegraphy, wireless, on submarines 234
Telephone, artillery type, composite 111
Telephotography.......... 361
Tests of coal, comparative 167
Tests of F. C. system shown graphically 112
Torpedo, firing of by gyroscope 106
Torpedo, new French.......... 106, 235
Toulon, harbor obstructions 326
Training and organization of coast artillery troops.......... 247
Tubes, gun, erosion of 296
Tug, nignt shore signals 114
Tungsten-coated silver lamp filament 360
Tungsten lamp filament, brittleness overcome 109
Turrets, gun, twin and triple 105
12-inch 50-caliber naval gun, Vickers 185
Uniform, French, new service 359
Uniform, wearing of, advertising the army 279
Vickers' ordnance at the Japan-British Exhibition 182
Viribus Unitis, Austro-Hungarian battleship 356
Voltaire, French battleship 344
Von der Tann, British turbine-cruiser (illustration), opposite..... 119
War material in 1910, progress of 357
Warship armaments.......... 95
Welding armor plate, new method 355
Wet guncotton, some remarks on 101
Wireless telegraphy on submarines.......... 234
Wireless telegraphy, preventing interception of messages........ 360
Wyoming (U. S. Battleship) compared with *Jean Bart*, *Rivadavia*
    and *Sebastopol* ....

III. Book Reviews.

Battle of the Wilderness, The ....
Bone and Hoof Diseases of the Horse..........
Campaign of Chancellorsville, The..........
Cavalry Tactics as Illustrated by the War of the F
Engineering Abstracts ....
Manual for Aspirants for Commission in the
    vice, A ....
Military Topography for Mobile Forces .....
Mountain and Colonial Artillery ....
Nautisch-technisches Worterbuck, Part II
Strong Vincent and His Brigade at Getty
Tactics. Vol. 1. Introduction and For
Taschenbuch der Kriegsflotten, 1911 .

Seco
Selection a
Signals to tug fr
Smithsonian Institut
Smokeless powder tests, n
Steel, Thermit, improving t
Stiffness of guns ....
Stowage of battleship boats ....
Strength of magnetic fields, mea
Submarine cable-laying and repairi
Submarines:
- *Hvalen* (Swedish) illustration, o
- Laurenti class ....
- *Seal* (Lake), distinctive features o
- wireless telegraphy on ....

Supports, Coast Artillery, organization and t
Sweden: Submersible *Hvalen*, illustration, o
Tables and notes from C. A. D. R. ....
Target practice:
- British navy, Years 1907-08-09-10 ......
- French navy, 1910, results ....
- German navy, 1910 ....
- reports, analysis of ....

Signals .
Smithsonian
Smokeless powder t
Steel, Thermit, improvin
Stiffness of guns . . . .
Stowage of battleship boats . .
Strength of magnetic fields, m
Submarine cable-laying and repai
Submarines:
    Hvalen (Swedish) illustration,
    Laurenti class . . . .
    Seal (Lake), distinctive features o
    wireless telegraphy on . . . .
Supports, Coast Artillery, organization and t
Sweden: Submersible *Hvalen*, illustration, o
Tables and notes from C. A. D. R. . . . .
Target practice:
    British navy, Years 1907-08-09-10 . . . . . .
    French navy, 1910, results . . . .
    German navy, 1910 . . . .
    reports, analysis of . . . .

Frontispiece.

Photograph by Carl Speck, Kiel.

THE GERMAN HIGH-SEA FLEET.

Deutschland,
Schlesien, Hannover,
Zaehringen, Wettin, Wittelsbach, Hessen, Schleswig-Holstein, Hertha, Luebeck,
Preussen, Braunschweig, Yorck, Roon,
Pommern, Elsass, Lothringen, Nuernberg, Mainz, Stuttgart, Berlin,
Gneisenau, Danzig,
Stettin.

JOURNAL
OF THE
UNITED STATES ARTILLERY

*"La guerre est un métier pour les ignorans
et une Science pour les habiles gens."*

VOL. 35 No. 1 JANUARY–FEBRUARY, 1911 WHOLE No. 107

THE SELECTION AND DEFENSE OF NAVAL BASES

BY COLONEL MARTIN,—AN EX-CONFEDERATE OFFICER

The first objective in a war between two nations entirely separated by the sea is control of the sea; for the side that obtains such control secures immunity from invasion and power to invade the enemy's territory. Until the control of the sea is determined the land forces of the contending powers must play a subsidiary part. They can assist their respective navies most effectively by holding those naval bases and coaling stations that are essential to the service of the fleets in the contest with the enemy's fleets. Under special circumstances they may enter directly into the contest for naval supremacy by attacking the enemy's naval bases; but, except for this purpose, any attack upon the enemy's oversea territory, while the contest for the sea is still doubtful, merely diverts naval forces from the contest with the enemy's main fleet, distracts public opinion from the real point at issue, and isolates military forces where they may be attacked and captured at the discretion of the enemy if he gains the control of the sea.

Such in outline is the naval policy that has been pursued by England for more than four centuries. When the great fleet actions have been fought and won, the way has been clear for the army to step in and give the finishing stroke; and the enemy's islands and transmarine possessions have fallen, one by one, to the victor's oversea expeditions.

With the capture of Gibraltar in 1704, England began her system of strategic bases by which she has supported her dominion of the seas and of the fairest portions of the earth's surface. As this dominion grew she dotted the face of the earth with naval stations which, together with her squadrons, and her use of small oversea expeditions, have been the chief elements of her success. These bases have enabled her to make the enemy's waters rather than her own the theater of war, to treat the hostile coast strategically as the British frontier, and to hold the sea as territory which the enemy must be prevented from invading. Without this system of bases, which has given her most of the advantages of nearness to the scenes of great operations, her squadrons and her military forces would have afforded a very precarious strength.

We have deliberately made our own certain foreign policies which demand the possession of a first class navy:* We are fully committed to the enforcement of the Monroe Doctrine which continually assumes new aspects and brings new responsibilities; we have taken over Porto Rico, Hawaii and the Philippines, and are responsible internationally for Cuba; and we are building and we intend to hold the Panama Canal. These things cannot be done unless our fleets are assisted by properly selected and defended naval bases abroad. As we are just entering upon the establishment of naval bases we are in a position to profit by the lessons of experience and to avoid the disasters that have been due in the past to the injudicious selection of sites for naval bases.

I purpose in this paper to review the subject of the selection and defense of naval bases considered as a means of strengthening fleets and increasing their radius of action.

ARE NAVAL BASES LESS NECESSARY TODAY THAN FORMERLY?

We are met at the outset by the question as to whether recent mechanical improvements, the introduction of liquid fuel, the opening of coal mines in almost all quarters of the globe, and the increase of coal shipments by sea, have not lessened the need of yards and coaling stations abroad or done away with it altogether. Almost every probable theater of naval war is surrounded, as it were, by neutral ports whence coal can be shipped to the opposing fleets; the sea is covered with tramp steamers whose captains are eager to supply belligerents with contraband of war; the use of liquid fuel renders the renewal of fuel supply at sea a relatively simple matter; and, finally, the voyage of the American fleet around the world has demonstrated that a fleet can arrive at the antipodes in excellent condition for battle. Many therefore believe that distant naval bases are no longer needed.

---

* President Roosevelt, Annual Message, Dec. 2, 1902, Foreign Relations of the U. S., 1902, p. XXVI.

On the contrary careful consideration will show that naval bases are more necessary at present than they have ever been. Comparatively recent changes in international law have very nearly closed neutral ports to belligerents; the renewal of fuel is a want more urgent, more peremptory, than any known to the sailing ship;* and the necessity for succor and repair after battle has greatly increased with improvements in material. Confederate cruisers using a combination of sail and steam power kept the sea for years without touching at a Confederate port; but such feats would be impossible today, on account of more stringent neutrality laws and the increased amount of fuel required for steam vessels. A century and a quarter ago Suffren could deliver three hard fought battles and make all needed repairs in open roadsteads, but no navy today could fight a worthy antagonist and refit by means of a floating repair shop. The Russian fleet would not have undertaken its voyage to the Far East had the Japanese been able to deny Vladivostok to it as effectually as they did Port Arthur. The scenes that attended the scattered Russian vessels seeking refuge in neutral ports after the battle of Tsushima will probably be re-enacted after every hard fought battle in the future unless friendly ports are near at hand. As regards badly disabled vessels this will be true even for the victorious side. Commerce destroying may be said to be an article of national faith with us; but unless we have allies or naval ports abroad, it will be possible only in the vicinity of our own shores which will be avoided by the enemy's shipping, as few trade routes pass near our ports that do not end at one of them.

"If, at every period of naval history," says Captain Darrieus of the French Navy, "fleets have had pressing need to secure 'advanced bases,' centers for laying up, revictualing, etc., where the ships can go to be repaired, to get new supplies, or even merely to rest, above all during the winter, from the fatigues of long cruising, never have these 'bases of operations' been more indispensable than nowadays.

"When the wind was the only moving force, a fleet well provided with food and ammunition could, if need there were, keep the sea for long months, at a pinch even put in to port on a foreign coast. It is thus that our great Suffren, in his immortal campaign of the Indies, remained away from Reunion, his only friendly port, during twenty-two consecutive months. I hasten to recall, furthermore, that he would have had no rest if he had not conquered the advanced base which he lacked, which he accomplished by capturing Trincomalee.

---

* Influence of Sea Power Upon History, Mahan, p. 329.

"In our time, needs of this kind are infinitely more pressing. Though modern ships of war carry enough food to suffice for the nourishment of their crews for several months, on the other hand they only hold the coal necessary for the maintenance of propulsive power for a few weeks, one may even say a few days. The obligation to return frequently to port for fuel is therefore imperious. Moreover steel hulls in sea water become covered with grass and barnacles; under penalty of seeing the high speeds which are a strategic factor of the first importance greatly reduced, periodic visits to a dock are necessary.

"Thus far I have considered only the exigencies of the daily life of fleets. What must there not be added, when one thinks of the needs entailed by bad weather, of the repairs of all sorts necessary to restore to fighting trim the ships composing a naval force which has been in battle, *even if victorious.*

"Modern bases of operations, therefore, require considerable supplies of provisions, ammunition, coal, lubricants, spare articles, raw materials, etc., dry docks, repair shops well equipped with tools, etc., all under the safeguard of defences which cannot be too strong, since the question is to guarantee the security of the preparations of naval operations.

"Remember that it was much more from the almost complete lack of means of action of this sort than from the individual weakness of his ships, that Admiral Cervera's unfortunate squadron perished at Santiago de Cuba; for his four cruisers would still have been able to play a good part if they had been *active*, if they had been provided with the things most essential to their very life."*

DESIRE OF BELLIGERENTS TO FIGHT NEAR THEIR NAVAL BASES

The dependence of fleets upon naval bases is shown by the desire of belligerents, throughout the era of modern naval warfare, to fight near their bases. It is interesting to note that there has never been a great naval battle in mid-ocean.

---

* War on the Sea, Darrieus, Alger's Translation, pp. 146-147.

The Dutch in their three great naval wars with the English "seldom voluntarily engaged out of sight of their own coast."* Napoleon writing to Villeneuve in May, 1805, said: "If you adopt the plan of forming a junction with the Brest squadron, you should endeavor to do so without fighting; but if this proves too difficult, *arrange to fight as near Brest as possible.*"† Later in the same year Nelson returning from the West Indies in pursuit of Villeneuve said to his Captains: "If we meet them we shall find them not less than eighteen, I rather think twenty, sail-of-the-line, and therefore do not be surprised if I should not fall on them immediately; we won't part without a battle. *I will let them alone till we approach the shores of Europe,* or they give me an advantage too tempting to be resisted."‡ During the recent war in the Far East many people expected Togo to attack Rojestvensky in the North Sea, or within sight of Madagascar, or at the entrance to the China Seas, or in the Formosan Straits. But the Japanese lay in wait at the passage of the Korean Straits in close proximity to their naval bases where their maximum means of action were available, fighting ships, cruisers, torpedo boats,§ as well as facilities for succor and repair after battle.

An incident in the second Dutch war related by Admiral Colomb affords a striking illustration of the benefit of fighting within reach of a well equipped, well provided naval base. Sails have given way to steam, and the nations now fight in iron ships; but the teaching is good for all time and enforces a lesson that we are near to forgetting. The English fleet had been badly defeated by the Dutch with a loss of ten or eleven ships, nearly 600 killed, 1,100 wounded, and 2,000 prisoners; and the rest of the fleet had withdrawn badly shattered to Sheerness, then as at present a naval station below London at the place where the Medway joins the Thames. "The Dutch," says Colomb, "had so far gained a victory, but they were under the impression not that the victory was more complete, but that its effects were more permanent and far reaching than they really were. In their mistaken view they not only hurried their fleet of sixty sail out of the Texel on the 25th of June, but prepared with it a fleet of transports carrying troops, in order to make a descent on our coast, having by their victory, as they supposed, secured themselves from interruption at sea. With this fleet, considerably reinforced from other ports, they appeared at the mouth of the Thames. But at the Nore, to their disappointed astonishment, lay a new English fleet computed at eighty-eight sail, with fire ships and ketches. These ships were the repaired and refitted remains of the beaten fleet, with additions, all collected and approaching completion, by the great exertions of Sir William Penn, now one of the Commissioners of the Navy.

---

* Naval Warfare, Colomb, p. 75.

† Ibid, p. 185. Italics in this and subsequent quotations are the present writer's.

‡ Influence of Sea Power on the French Revolution and Empire, Mahan, Vol. II, p. 172, quoting from Nelson's Despatches, Vol. VI, p. 457; see also Mahan's Life of Nelson, p. 665.

§ War on the Sea, p. 231.

"The Dutch hopes were entirely frustrated by this unexpected sight, and they found themselves reduced to carrying out the simple operation of blocking the Thames, which they did till the 19th or 20th of July, when the English fleet put to sea after them,"* and, it may be added, won a substantial victory a week later.

NAVAL BASES SHOULD BE CAPABLE OF DEFENDING THEMSELVES

It is plain that a distant naval base, if it is not to be a hostage to foreign powers, should be able to defend itself for a reasonable time without outside assistance; but a few writers of great influence and authority maintain that fortifications are not necessary and that the best defense for a naval base is the fleet itself. They contend that the fleet can defend its own base tactically, by its presence at the base, or strategically, by its ability to appear upon the scene when necessity arises. Those who hold these views, the so-called Blue Water School, have made much of the fact that the nation having the superior navy almost invariably captures its opponent's bases. They ignore the self evident truth that fleets and bases are both elements of sea power; that bases exist to increase the fleet's radius of action, and are of no use to a nation without a fleet; that bases are fortified in order to give fearless freedom of movement to the fleet and release it for its proper offensive work; and that a fleet by capturing a naval base may increase its own radius of action and decrease its opponent's.

These uses and advantages are well illustrated by a classical naval campaign upon which naval writers love to dwell.

In 1782 the French fleet under Suffren in Indian waters was very evenly matched with the English fleet under Sir Edward Hughes. Three pitched battles had been fought without decisive result when Suffren in the month of August found himself at Batacalo in the eastern part of Ceylon sixty miles southeast of Trincomalee. He had reasonable assurance that Hughes was at or near Madras at a considerably greater distance to the north of Trincomalee. In the southwest monsoon, which blew at this season of the year, he could reach Trincomalee in half a day while it would take Hughes two weeks to beat up from Madras. He himself was without a naval base and he had not the wherewithal to equip one. The English had a secure base at Madras and a secondary base at Trincomalee which depended upon the fleet for protection. With the force that he could spare for operations ashore he could reduce Trincomalee before Hughes could come to its rescue. He therefore determined to attack Trincomalee. On August 25th he appeared before the place, which surrendered on the 31st, two days before Hughes came up. Thenceforth Suffren operated from the naval base which the English had prepared for him.

---

* Naval Warfare, p. 55.

"With his usual promptness," says Captain Mahan, "the French commodore had prepared for further immediate action as soon as Trincomalee had surrendered. The cannon and men landed from the ships were at once re-embarked and the port secured by a garrison strong enough to relieve him of anxiety about holding it. This great seaman, who had done as much in proportion to the means intrusted to him as any known in history, and had so signally illustrated the sphere and influence of naval power, had no intention of fettering the movements of his fleet, or risking his important conquest, by needlessly taking upon the shoulders of the ships the burden of defending a seaport. When Hughes appeared, it was past the power of the English fleet by a single battle to reduce the now properly garrisoned post. Doubtless a successful campaign, by destroying or driving away the French sea power, would achieve this result; but Suffren might well believe that, whatever mishaps might arise on a single day, he could in the long run more than hold his own with his opponent.

"Seaports [naval bases]* should defend themselves; the sphere of the fleet is on the open sea, its object offence rather than defense, its objective the enemy's shipping wherever it can be found."†

Again in commenting on Suffren and Hughes' campaign, Captain Mahan says: "The dependence of Trincomalee upon the English fleet in this campaign affords an excellent illustration of the embarrassment and false position in which a navy finds itself when the defense of its seaports [naval bases] rests upon it. This bears upon a much debated point of the present day, and is worthy the study of those who maintain, too unqualifiedly, that the best coast defense is a navy. In one sense this is doubtless true,—to attack the enemy abroad is the best of defenses; but in the narrow sense of the word 'defense' it is not true. Trincomalee unfortified was simply a center round which Hughes had to revolve like a tethered animal; and the same will always happen under like conditions."*

---

* The brackets, here and following are the present writer's.

† Influence of Sea Power Upon History, p. 452-453.

To collect vast supplies of valuable war materials at such places without providing tactically for their security is to labor for the enemy's benefit. A nation's war policy is badly at fault and its outlook when war begins will be gloomy indeed if its naval stations cannot hold out for a reasonable time without assistance from the fleet.†

NAVAL BASES MUST BE PROVIDED WITH MEANS OF DEFENSE AGAINST LAND ATTACK

The necessity of providing bases with means of defense against the direct attack of naval vessels has generally received ample consideration; for those who have written on the subject and those who have been chiefly instrumental in selecting naval bases have, because of their professional environment, been thoroughly imbued with the possibilities of this method of attack; and, as a result, naval bases have been carefully placed well within landlocked harbors beyond bombarding distance from the sea. On the other hand, defense against land attack has received little consideration from writers and has been well nigh ignored in the selection of sites for naval bases. Most seaports may easily be protected by seacoast defenses from direct naval attack; the difficulties of land defense are greater on account of the greater number of men required, and the persistence with which land attack may be carried on. These difficulties are increased in proportion as the port is retired inland from the sea.

Quotations could be multiplied almost indefinitely showing that writers when they speak of *future* attack upon naval stations and coast cities have in mind nothing more than the possibility of purely naval attack unaccompanied by land attack. Thus Captain Mahan, who reasons so well upon past events, writes as follows in an article on "Preparedness for Naval War" which first appeared in *Harper's New Monthly Magazine* for March, 1897: "Coast defence implies coast attack. To what attacks are coasts liable? Two principally,—blockade and bombardment. The latter being the more difficult, includes the former, as the greater does the lesser. A fleet that can bombard can still more easily blockade. Against bombardment the necessary precaution is gun-fire, of such power and range that a fleet cannot lie within bombarding distance. This condition is obtained, where surroundings permit, by advancing the line of guns so far from the city involved that bombarding distances can be reached only by coming under their fire. But it has been demonstrated, and is accepted, that, owing to their rapidity of movement,—like a flock of birds on the wing,—a fleet of ships can, without disabling loss, pass by guns before which they could not lie. Hence arises the necessity of arresting or delaying their progress by blocking channels, which in modern practice is done by lines of torpedoes. The mere moral effect of the latter is a deterrent to a dash past,—by which, if successful, a fleet reaches the rear of the defenses, and appears immediately before the city, which then lies at its mercy.

---

* Influence of Sea Power Upon History, p. 430.

† Art of Naval Warfare, Bridge, p. 137.

"Coast defense, then, implies gun-power and torpedo lines as described."

* * * * * *

"Even coast defense, however, although essentially passive, should have an element of offensive force, local in character, distinct from the offensive navy, of which nevertheless it forms a part. To take the offensive against a floating force it must itself be afloat—naval."

* * * * * *

"Such are the main elements of coast defense—guns, lines of torpedoes, torpedo boats."

* * * * * *

"What force can they bring against us? That force must be naval; we have no exposed point upon which land operations, decisive in character, can be directed. This is the kind of hostile force to be apprehended."*

* * * * * *

This was written before our forces captured Santiago, but after the events of the Chinese-Japanese war had shown the necessity for guarding the back door. That the author would apply the same plan of defense to naval stations abroad may be seen from the following list of what he considers eligible places for naval bases in the Carribean Sea, given in an article in the same magazine seven months later: Cartagena, Chiriqui Lagoon, Colon, Curacao, Martinique, Santa Lucia, St. Thomas, Samana Bay, Santiago, Kingston, Cienfuegos, Mujeres Island, Key West, Pensacola, Mouth of the Mississippi River.* If we except Key West and the places on the mainland of the United States which could receive reinforcements after the outbreak of war, it would be difficult to pick out of this list more than one or two places which could be held at the outbreak of war by such garrisons as even the most militant first-class power would maintain in time of peace to protect naval bases.

---

* The Interest of America in Sea Power, Mahan, pp. 194-5-7-9.

It is almost useless to make fortified harbors impregnable from the sea if they are left open to land attack. This is true even of our continental seaports but it is doubly true of our insular naval bases. It is worse than useless to establish permanent naval stations abroad unless we insure, as far as human ingenuity can, their safety from foreign seizure.†

DEFENSIBILITY NOT LESS IMPORTANT THAN STRATEGIC SITUATION

Strategic situation, that is, nearness to insular or transmarine dependencies, to probable theaters of war, or to trade routes, is, of course, a *sine qua non* for a naval base, but it is a common error to assume that any seaport fulfilling this requirement can easily be made to fulfill all others. Even Captain Mahan seems to share this misconception. He says: "The strategic value of any position, be it body of land large or small, or a seaport, or a strait, depends, 1, upon situation (with reference chiefly to communications), 2, upon its strength (inherent or acquired), and 3, upon its resources (natural or stored). As strength and resources are matters which man can accumulate where suitable situation offers, whereas he cannot change the location of a place in itself otherwise advantageous, it is upon situation that attention must primarily be fixed. *Strength* and resources *may be artificially supplied or increased*, but it passes the power of man to move a port which lies outside the limits of strategic effect. Gibraltar in mid-ocean might have fourfold its present power, yet it would be valueless in a military sense."‡

---

* The Interest of America in Sea Power, p. 271.

† President Roosevelt, Annual Message, Dec. 8, 1908, remarks on Pearl Harbor.

‡ The Interest of America in Sea Power, p. 283.

It may just as truthfully be said that in spite of its situation Gibraltar would be valueless if it were indefensible.

Tangier across the strait from Gibraltar has as good a situation, in the sense in which Mahan uses the term, as Gibraltar, a far better harbor, and, what Gibraltar lacks, a "plentiful and good"* supply of fresh water easily tapped and an abundance of wharf space. It has been in the power of the nations that have long coveted Gibraltar to establish a naval station at Tangier at various times since Tangier was abandoned by the English in the reign of Charles II. What but the great difficulty of supplying artificial strength where inherent strength is lacking, has kept it from becoming a better naval station than Gibraltar?

The importance of considering inherent strength or defensibility in the selection of sites for naval bases arises from the fact that, in the nature of things, a nation cannot and will not go to unlimited expense in fortifying bases and providing garrisons for them. A place strategically well situated may be capable of defense only at a cost out of proportion to its value. Only under exceptional circumstances can distant naval bases be reinforced at the outbreak of war. Even were it otherwise, it would be poor economy to occupy stations that require armies for their defense.

EFFECT OF TOPOGRAPHY ON THE CHOICE OF SITES FOR NAVAL BASES

Ease of defense depends largely upon topography. Naval bases may be built on a bay of a continent or a large island; on a small peninsula; or on one or more islands of such limited extent of shore line that the enemy may be met at the water's edge and prevented from landing.

1. Of these the most difficult to hold against land attack is the position on a bay of a continent or large island; for the defense of the anchorage, the plant, and the coast defenses of a base so situated will require the occupation of a line from a few miles to forty or fifty miles long. Against such a place the enemy can carry on siege operations,—regular approaches, bombardments from concealed batteries, and land mining operations in connection with the assaults of infantry. Few ports on the mainland are as well situated for defense as Port Arthur where the land front was only fourteen miles long. Bases have been selected on magnificent harbors on the mainland in recent times which would require more than forty miles of land defenses

---

* The Mediterranean Pilot, Vol. 1, 1904, p. 97.

to be held. Subic Bay, Sorsogon Bay, and Guantanamo are of of this class of which Vigo Bay, where the English made a holocaust of a great French and Spanish fleet in 1702, is the great archtype. Port Arthur upon two occasions, Santiago, Wei-hai-wei, and, above all, Port Mahon, illustrate the weakness of such positions. Nearly every naval war has furnished one or more examples. On account of the difficulties of defense, the mainland of continents and large islands may therefore be eliminated as possible places for naval bases, except in the home country where they are surrounded by a friendly population and defended by the military forces on home service.

2. A small peninsula like Gibraltar or Tsingtau (Kiaochow) connected with the mainland by an isthmus comes next in the scale of easy defense. The enemy, however, can still carry on regular siege operations against such a place though upon a more limited front. The defense of Gibraltar and of Fort Pickens illustrate the strength of well chosen positions on small peninsulas.

3. Islands upon which the enemy can be prevented from landing, such as Corregidor, Culebra, and the Pescadores, are easier to defend than any position on the mainland, because the best field of fire is a water area and the most easily defended position is a water front over which the enemy must advance in small boats. If the shores of a part of the island are precipitous and unscalable the task of the defenders is lessened; a few riflemen and machine guns, and an occasional field gun in addition to the necessary seacoast armament will render them unassailable. Coral reefs and sunken rocks, if present, will add to the natural strength of the position and reduce the forces required. If the island is in the tropics the monsoons or trade winds may render landing difficult or impossible on one half of the shore of the island for a part of the year. The defense of Cadiz, Mantua, Diamond Rock, and Fort Sumter (by the Confederates) in modern times and of Ravenna, Tyre, and Cyzicus in ancient times, and the long history of Venice, illustrate the great strength of positions on small islands surrounded either by the sea or by inland waters and marshes. Mahan's description of Elba sums up conditions in regard to defense that should be borne in mind by those charged with the great responsibility of selecting permanent naval bases. "Midway . . . . . . lay the since famous island of Elba, a dependency of Tuscany, so small as to be held readily by a few good troops, and having a port large enough, in Nelson's judgment, to harbor the British fleet with a little

management."* But it should be remembered that only a very small part of a nation's war fleet would ever really need to enter the harbor of a distant naval base at any one time.†

PERMANENT BASES AND ADVANCE BASES

The permanent naval bases of which we have been speaking should not be confounded with advance bases seized for operations as near as possible to the center of the theater of war, usually on the enemy's coast, where, for obvious reasons, it is impossible to establish permanent bases in time of peace. Thus, while Nelson was able to base his fleet directly on Gibraltar during his watch off Cadiz immediately preceding Trafalgar, he used Madalena Bay in the straits between Corsica and Sardinia as an advance base during his two years' watch off Toulon for the French fleet, his main base being at Gibraltar; and the Japanese during their operations against Port Arthur, in spite of the proximity of the theater of war to the great naval bases in Japan, used one or more advance bases, always referred to in despatches as a "certain place," as near as possible to the point of attack.‡ Advance bases are also used to assist in securing commercial routes or maritime control in a region where undisputed naval supremacy has been acquired.

Permanent bases are points of departure from which an expedition may make a refreshed and final start for its objective; advance bases are points of rendezvous from which storeships and repairships may assemble and minister to the needs of the fleet and where the fleet itself may lie while lookout vessels keep in touch with the enemy's fleet. In selecting the site and planning the defenses of a permanent naval base all possible powerful enemies in the indefinite and uncertain future must be considered; permanent bases must therefore be prepared to hold out against the tempest of destruction that may be brought to bear upon them by enemies having temporary local command of the sea. Advance bases are selected for immediate use against a particular foe in a region where the command of the sea is assured; hence extensive preparations against naval attack pure and simple or in combination with land forces are not required for advance bases. These bases are quickly and easily established with material kept in readiness in time of peace; and they are as readily abandoned when, from necessity or a change of policy, the fleet withdraws, as readers of Mahan will recall in connection with the withdrawal of the British fleet from the Mediterranean in 1797.

---

* Life of Nelson, p. 202.

† Sea Power and Other Studies, Bridge, p. 250.

‡ War on the Sea, p. 154.

As the enemy is on the defensive and fully occupied when advance naval bases are required, it sometimes happens that an advance base can be seized on the mainland and defended by a small force that would have been captured at an earlier stage of the war when the enemy was free to take the offensive against it. Thus we seized Guantanamo on the mainland of Cuba in 1898, at a time when the Spanish were occupied with the defense of Santiago. A disproportionate number of men would have been required to hold it at the outbreak of war had it been in our possession as a permanent base by treaty rights at the beginning of the war. Permanent naval bases on the mainland should have great intrinsic strength, as is the case with Gibraltar and Tsingtau. The ease with which temporary advance bases, seized when the enemy's forces are fully engaged on the defensive, have been defended, has led in some notable instances, to their permanent occupation when the surrounding territory has passed by treaty to the side which seized them. The fact that the native population, at one time friendly, may be hostile and in alliance with the enemy when the next war breaks out, is overlooked, as well as the possibility that the enemy may have command of the sea. These remarks apply in principle to nearly all the naval stations seized by the European powers on the China coast. Boston and Toulon when held by the British are also examples in point. In regard to Toulon Mahan says: "The expenditure of men and money necessary to hold a seaport surrounded by enemy's territory, and commanded by a long line of heights which had to be occupied, would have been out of proportion to any result likely to follow."* The ill consequences that may follow the occupation of such places are exemplified by the recent history of Port Arthur. Japan, taught by the mistakes of her enemy, is pursuing a different policy. Port Arthur, it appears, is not to be an important naval base. It may be added that, had Japan followed European and American precedent when she selected her Formosan base, she would have chosen Keelung on the mainland of Formosa. Instead of this she has chosen the Pescadores Islands.

---

* Influence of Sea Power on the French Revolution and Empire, Vol. 1, p. 106.

FORTIFYING HARBORS IN ORDER TO PREVENT AN ENEMY FROM USING THEM AS ADVANCE BASES

Probably no one has ever advocated a particular site for a permanent naval base without alleging the advantage that would arise from depriving the enemy of the use of it as a site for an advance base. This argument is never challenged and yet a little reflection will show that it is fallacious. If the best site for a permanent naval base in any maritime region be selected, it will be found that there will still remain a large number of sites which would serve satisfactorily for temporary advance bases; for, as we have seen, the requirements to be fulfilled are much less exacting for advance bases than for permanent bases. Furthermore, as illustrated by the Japanese in the recent war, it is not only easy to change the position of advance bases but it is advantageous to do so in order to keep the enemy in ignorance of their exact situation. If the argument were ever applicable to any maritime region it would be applicable to the Hawaiian Islands. It has been asserted that Honolulu and Pearl Harbor are the only possible places that could be used by an enemy in the vast expanse of the North Central Pacific, as an advance base against the United States. An examination of the Sailing Directions for the Hawaiian Islands will disclose the fact that there are at least a half dozen anchorages outside the Island of Oahu that could be used for this purpose. Most of these anchorages, it is true, are good for a part of the year only on account of exposure to the prevailing winds, but the facility* with which advance bases can be moved will enable an enemy to select a sheltered anchorage at any season of the year. Moreover the United States is now improving the harbor of Hilo in the Island of Hawaii, the best anchorage outside of Oahu, so as to provide a secure anchorage throughout the year. The recent visit of foreign war vessels to this harbor confirms the writer's view formed long ago, of the value of Hilo Harbor to an enemy, and incidentally of the futility of attempting to exclude an enemy from any maritime region by fortifications, especially from regions in which harbors abound, like the West Indies and the Philippines.

FAULTY USE OF NAVAL BASES

The faulty use of naval bases abroad has done much to raise a prejudice against them. Thus inferior naval forces which ought to have been withdrawn to the home country prior to the outbreak of war have frequently been allowed to be shut up in such bases. This has resulted from an unwise application of the doctrine of the "fleet in being." By this doctrine an inferior fleet locked up in one or more impregnable ports in the home country imposes upon the enemy the intense and continuous strain of watchfulness against escape. This is what Torrington, the author of the phrase, purposed to do when his fleet was inferior to the French fleet.* The practice may or may not be correct for an inferior fleet based upon home ports. Its application to the defense of indefensible naval bases abroad is fatal to concentration, which is as vital in sea as in land operations. In both classes of operations concentration should take place at such a distance from the enemy as to be safe from interruption. The concentration of forces in close proximity to an active enemy is even more hazardous on the sea than on land. The Japanese would not have permitted the concentration of the Baltic, Port Arthur, and Vladivostok squadrons in Far Eastern waters,† but the concentration of these forces in Madagascar or Europe could have been effected prior to hostilities and would have given an incontestable superiority to the Russian naval forces. As to the manner in which such a concentration should have been made, the way in which our own naval vessels disappeared from Asiatic waters during the war scare of 1907 furnishes an excellent suggestion. When naval forces are compelled to seek refuge behind land defenses, the harbor of refuge should be in the home country where facilities for reinforcement and recuperation are the greatest and where, at least, they will be protected on the land side by the land forces of the nation. The French vessels that took refuge in the ports of France during the long naval wars between the French and the English at the beginning of the last century were safe from capture and were frequently able to try their fortunes again at sea, but those that sought shelter in France's naval bases abroad were almost all captured before the end of the war. Port Arthur and Santiago are recent examples of the cutting off and capture of naval forces in distant naval bases. The presence of squadrons in these places, far from adding to the strength of defense, only added difficulties and increased the value of the prizes.

---

* Sea Power and Other Studies, p. 294.

---

* Lessons of the War with Spain, pp. 78, 84, 123;
Naval Warfare, pp. 122, 438;
Sea Power and Other Studies, pp. 47-51, 79.

† Naval Administration and Warfare, pp. 168-170.

A Capacious Harbor is not a Necessity at a Naval Base

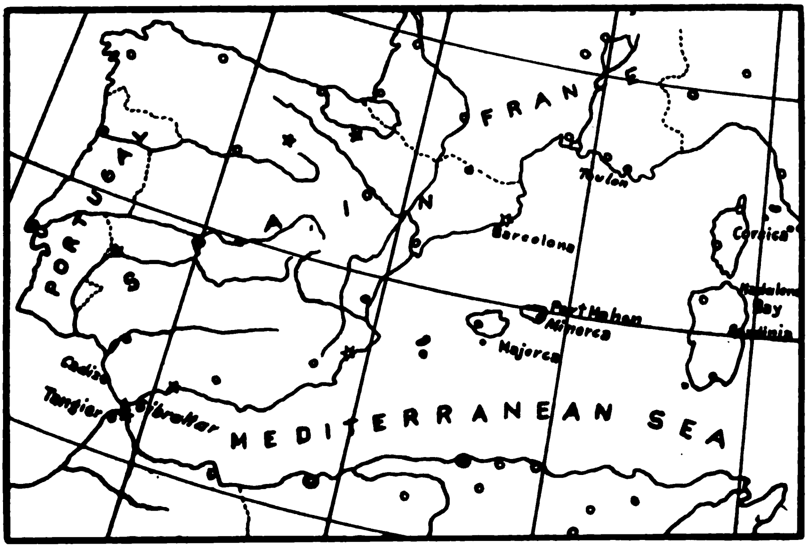
Another delusion regarding naval bases is that they should be on capacious harbors. "Forty battleships" is the consecrated number for which accomodation is usually deemed necessary. Under what conceivable circumstance would forty battleships need to take refuge in a port? Harbors affording such accomodation can be found only in the mainland of continents or large islands, never in small islands; because small islands, such as can be defended at a reasonable expenditure of men and material, cannot contain such big harbors; in fact, the areas of the harbors usually selected are so great that medium sized garrisons could not even defend islands of the same area. Gibraltar and the so-called neutral ground could easily be set down in either Subic Bay or Sorsogon Bay; Corregidor and its dependent island, Caballo, if placed in their relative positions in either of these bays would be surrounded by navigable water. The defense of these extensive harbors requires the holding of land lines around them much greater in extent than the perimeters of the harbors. All history proves that such lines cannot long be held. When military and naval men come to recognize this truth, we shall be delivered from attempting the defense of indefensible positions in foreign lands.

The delusion in regard to the necessity of capacious harbors for naval bases is not of recent origin. Admiral Colomb, in discussing, about the year 1895, the relative merits of Port Mahon and Gibraltar as naval bases, gave utterance to a doctrine that has always gained many adherents during intervals of peace. "Of the two places," says Colomb, "Minorca [Port Mahon] was by far the most important. Gibraltar never had been, and never could be, so good a base to operate from as Minorca. Geographically it was too far from the French coast, while Minorca was placed nearly midway between Toulon and Cadiz. The anchorage of Gibraltar was contracted and detestable. Ships could not water there, and possible wharf space was very confined. It was attackable by land, and might be captured by land forces without the necessity of any covering navy. *Minorca, on the other hand, possessed one of the finest harbours in the world.* It was impossible to attack it by land forces alone unless the command of the sea was first assured."*

Minorca, an island in the Mediterranean has an area of 260 square miles. Landing places are numerous on the island outside of the lines that were formerly held at Port Mahon. The fine harbor was a convenience in peace but a source of weakness in war and by no means a necessity, either in peace or war. Like all naval bases on large harbors either in the mainland or in large islands it was easily captured by land when once invested. It is true that Gibraltar is attackable by land; but it is connected to the mainland by a narrow isthmus only, and the natural strength of the rock is such that a small garrison has been able to hold it for over 200 years against all attacks both by land and sea. The situation would, of course, be vastly improved if, like Corregidor or Culebra, it were on a small detached island that could be defended by preventing boats from landing. It is true that command of the sea is necessary before Minorca can be attacked; but the essential fact about Minorca is, that command of the sea being attained, Port Mahon can easily be reduced.

---

* **Naval Warfare, p. 367.**



The history of Gibraltar and Minorca illustrates the difference between a naval base with a poor harbor that can be effectually defended for a long period in the absence of the fleet and one with a fine harbor that can be defended for a short time only in the absence of the fleet. Gibraltar is typical of what may be expected of Corregidor, Culebra, and the Pescadores; Minorca of what may be expected of such places as Tangier, Guantanamo, Samana Bay, Sorsogon Bay, and Subic Bay.

In July, 1704, Gibraltar was taken by the English and the Dutch after four days of investment by land and sea. The garrison numbered 150 men, exclusive of the inhabitants; the investing force 9,000 or 10,000 men. It is said that the Governor was moved a good deal by the fact that the English and the Dutch had gotten between the town and a chapel where all of the women of the best families had taken refuge. The English fleet soon withdrew, leaving a garrison of about 2,000 men, but with insufficient supplies for a long siege. Soon after the withdrawal of the English fleet, the French and Spanish invested Gibraltar by land and sea and made numerous attacks. The English fleet relieved the fortress three times with men and supplies. The siege terminated in March, 1705, when the garrison was so well equipped as to be able to defy all attacks of the enemy. In 1720 the Spanish, under pretence of relieving Ceuta, which was besieged by the Moors, assembled forces in Gibraltar Bay with the intention of attacking Gibraltar; but they gave up their enterprise as a result of energetic measures for the defense of the fortress. In 1726 Gibraltar was besieged for four months by 20,000 men. It was again besieged for nearly three and one-half years from 1779 to 1782. During this interval it was relieved three times by the fleet. Thus in a period of 78 years after it was taken by the British, Gibraltar withstood three memorable sieges and defied an attempt to take it by surprise.

The history of Minorca presents an entirely different picture. The French took it from the Spanish in 1707. The following year it was taken "with a rush" by the English General Wade. The English fortified it carefully and in 1756 the garrison held out 70 days against the French. It was restored to England by treaty in 1763. In 1781-82 it stood out 170 days against the French and Spanish. As previously mentioned, the British fleet entirely withdrew from the Mediterranean in 1797, when Spain was on the eve of declaring war on Great Britain. Minorca, at this time, was a Spanish possession. In the summer of 1798, the British fleet again entered the Mediterranean. General Sir Charles Stuart was selected by the War Office, after consultation with Earl St. Vincent who commanded the English naval forces in the Mediterranean, to command a land force for the capture of Minorca. General Stuart pointed out the weak features of Minorca in a paper in which he stated that "though the fortress was strong, it was critically situated." The British were soon to realize the full signification of their general's criticism. In November, 1798, Stuart landed a small army on the island and captured Port Mahon. This was the fifth time that it had been taken in 91 years. It now became a serious clog on the movements of the British fleet, as may be perceived from the following extracts from the dispatches of Admiral Keith to Nelson:

1. "If Minorca is left without ships it will fall."

2. "I had no doubt of overtaking them [the French fleet] before they had left the coast of Italy; . . . *but the defenceless state of Minorca, without a fleet, the great force prepared* (*at Cartagena*) *to attack it,* added to my having so far exceeded my orders already, will oblige me to relinquish the pursuit, and return to the protection of that island."

3. "It is very hard I cannot find these vagabonds in some spot or other, and *that I am so shackled with this defenceless island.*"

It is true that Mahan, from whose pages the above extracts are quoted, has severely and, we think, justly criticised Lord Keith for being dominated by the fear of losing Minorca; but these quotations appositely illustrate "the embarrassment of a fleet upon which an important seaport wholly depends for security." They further serve to call attention to the predicament in which the British would have been placed had Minorca been a British possession when their fleet withdrew from the Mediterranean in 1797.* Could they have left it, we may ask, to the defense of a garrison? Could they have run the risk of repeating the disasters of 1756 and 1782? In explanation of Lord Keith's course of action we may venture to suggest that he may have had a lingering recollection that Admiral Byng had been tried by court-martial and shot for his failure to prevent the capture of Minorca in 1756.

Perhaps we should not marvel at some of the selections of naval bases made by our countrymen when such a distinguished naval critic as Admiral Colomb maintains that Port Mahon, which was captured five times in 91 years, was a better naval base than Gibraltar, and when such an illustrious writer as Mahan can speak of the same place as "one of the most advantageous naval stations in the Mediterranean."† Temporary command of the sea was sufficient for the capture of Port Mahon.

---

* It is worthy of note that Porto Ferrajo in the Island of Elba, which had been seized by Nelson in 1796 while the British held Corsica, was retained by a small garrison when they evacuated the Mediterranean and was held until the treaty of peace in 1802. "Being very small," says Captain Mahan, "Elba was more immediately under naval control than Corsica, and to hold it required fewer troops.

"In case of the loss of the larger island, it would still assure the British a base in the Mediterranean and continued control, so long as their fleet could assert predominance over those of their enemies." *The Influence of Sea Power on the French Revolution and Empire,* Vol. 1, p. 213.

† Life of Admiral Farragut, p. 1.

It lay within England's power to seize it for use as a temporary advance base for operations against the French coast if she saw fit to do so; but she realized, after her last experience, that it simply did not pay to try to maintain a permanent naval base at Port Mahon.

ONLY THE ESSENTIAL UTILITIES IN WAR NEED BE PUT IN THE PROTECTED AREA

A naval station is an industrial establishment with shops and facilities for refitment and repair employing a small army of mechanics and laborers. These agencies require a large area which is only less difficult to protect than a capacious harbor. The question of subsistence for a large force of civilian employees shut up in a besieged naval station brings up many difficulties which can be appreciated only by those who have been confronted with the practical difficulties of providing and keeping in store the food required for a military garrison for a long siege.

It cannot be too frequently stated nor too thoroughly understood that the only reason for the establishment and maintenance of a naval station is its utility and necessity in time of war. In time of peace the use of foreign shipyards can be purchased. Many features collect about a naval station that are not of vital necessity in war and the *raison d'etre* of a station as an element of sea power in time of war is too often obscured by its peace functions and neglected and forgotten. Where the difficulty of defending the station would be increased by attempting to defend both those utilities that are essential in war and those that are not, the non-essential should be left outside the protected area. Again, only those civilian employees whose services are essential during the siege need be subjected to the hardships of a siege. When a besieged naval base has been relieved by the arrival of a superior friendly fleet, the repair facilities in the protected area and the force of employees may be reinforced by facilities and mechanics brought with repair vessels accompanying the fleet.

TOWING DOCKS FROM PORT TO PORT WHEN HOSTILITIES THREATEN

But this does not mean that it would be permissible to leave an essential element of the station outside of the fortifications and in some place from which, when hostilities threaten, it would have to be towed *upon the high seas* to the base; for example, it would not be permissible to have Portsmouth, N. H., the peace station of a floating dock and Boston, Mass., its war station, relying upon the forbearance of the enemy to permit us to tow it from one place to the other. What shall we say when such a course is planned for a distant naval station near to a possible theater of war where at the outbreak of hostilities the enemy would inevitably have temporary control of the sea? As naval wars so often begin with successful attempts at surprise either before or immediately after the declaration of war,* an enterprising enemy would destroy the dock either at its indefensible peace berth or on the high seas while *en route* to its station.

Under no circumstances should the abandonment of tactically indefensible stations be postponed until hostilities threaten. At such a time the same clouded thinking and vacillation that cause their retention in peaceful times will sanction hopeless efforts to defend them with driblets of troops that are sorely needed elsewhere. To the extent that the fall of a place may be thus delayed, the magnitude of the disaster and the loss of prestige will be increased.

DEFENSE NEEDED FOR NAVAL BASES CONTRASTED WITH THAT POSSIBLE FOR OVERSEA DEPENDENCIES

A clear distinction should be made between the defense required for a naval base situated in a distant quarter of the globe and that required for island possessions in the same part of the world. The base is necessary to the fighting efficiency of the fleet; the islands are not. The defense of the base must be tactical; the defense of the islands may be strategical. The naval station cannot depend upon the fleet for protection without keeping the fleet within striking distance of the station. To do this the cost of maintenance of the fleet is greatly increased; officers and men are kept on foreign service; and ships are held where facilities of maintenance and repair are meager. If the fleet is not kept near the defenseless base, rumors of war which could be disregarded if the naval base were able to defend itself, will cause the fleet to make long and expensive voyages to protect its base. Such voyages are highly beneficial to the efficiency of the fleet but otherwise are undesirable from every point of view and are a severe penalty for the want of the higher discretion and judgment which the nation has a right to expect of its servants. The defense of the islands may be left largely to the fleet provided it has a well defended naval base in the islands or within the fleet's radius of action. The only effective defense, in fact, for insular possessions is a superior fleet which, by its ability to appear, when needed, and control the sea, will render it possible to land troops and attack any of the enemy's forces that may have effected a lodgment in the islands. The tactical defense of the naval base is therefore a necessary preliminary to the strategical defense of the islands. If the base is not defended by a force sufficient to hold it until the fleet can arrive, the fleet will find its base either destroyed or in the hands of the enemy and a great initial advantage, which counts for so much in war, will have been gained by the enemy before the fleets have met in battle.

---

* For example Port Arthur, night of February 8-9, 1904, and Chemulpo, February 9, 1904, before the declaration of war; Manila Bay, May 1, 1898, seven days after Spain's declaration of war; Copenhagen, April 2, 1801. In the contest between Great Britain and the Armed Neutrality in 1801, there was no formal state of war. Nelson destroyed the Danish fleet at its anchorage and would have destroyed the Russian fleet and perhaps the Swedish fleet at their anchorages had he been given a free hand by his immediate superior, Sir Hyde Parker. The general instructions of the British government fully justified such action.

History is replete with examples of land forces cut off in islands and compelled to surrender or make peace, from the time of Hamilcar Barca, who was isolated in Sicily and compelled to surrender by the defeat of the Carthaginian fleet at Aegates, to 1898 when Spain's large army in Cuba gave up the struggle as the result of the destruction of the Spanish squadrons in the West Indies and the Philippines, the capture of Santiago and Manila, and the overrunning of Porto Rico. As was so well exemplified in 1898, naval forces alone rarely end wars and compel a belligerent to sue for peace. This is particularly true with regard to continental powers, but it may well be believed that decisive defeat at sea would compel insular powers largely dependent on commerce, such as England and Japan, to make peace.

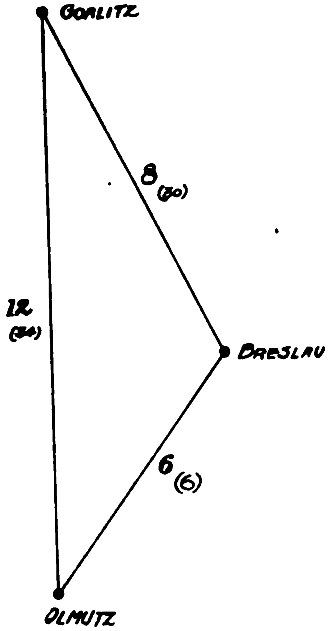
All places supplied from beyond the sea fall ultimately to him that holds command of the sea. The Philippines, garrisoned by the German Army on a war footing, could not be held against an enemy that has command of the sea and a small but effective army. These islands, like all tropical countries, produce little of the food required for white men, as such food can be raised in the tropics only with difficulty; and rubber, hemp, copra, sugar, tobacco, and similar products are too remunerative to permit the attention required to develop suitable varieties of food plants. An accumulation of stores could delay the fall of the islands; but the garrisons of outlying islands would fall one by one to the attack of land forces numerically weaker by far than the aggregate garrison of the islands; and all would succumb in time. No large land force would be needed for their defense by a nation having a superior fleet and a well equipped defensible naval base in the islands.

The Spanish attack on Sicily in 1718 affords an excellent illustration of the mutual relation of land and naval forces in the defense of insular possessions because of the leisurely and secure deliberation of the English and their Italian allies in attacking the Spanish troops in Sicily after the English navy had gained command of the sea. In July of that year a Spanish army of 30,000 men convoyed by 22 sail of the line seized the island of Sicily, except the fortress of Messina. In August a British fleet appeared off Messina under command of Admiral Sir George Byng, the father of the admiral who was shot thirty-nine years later for the loss of Port Mahon. War was not yet declared but the conquest of Sicily from a British ally was, according to Byng's construction of his orders, in itself such a declaration. He soon brought the Spanish fleet to battle which was a chase and a destruction, 23 out of 35 Spanish vessels present being taken or burnt. A month later Messina surrendered to the Spanish army. Having cleared the way for the reduction of Sicily, Byng allowed the matter to stand over for the winter according to the established course of warfare at that time. In the following spring he proceeded to Naples to concert measures to reverse the Spanish conquest. On October 7th the citadel of Messina surrendered to the land forces which had previously destroyed by artillery fire the Spanish men-of-war that had taken refuge under the guns of the citadel. Some of the Spanish forces were still at large in Sicily when peace was made but all important places were in the hands of the allies. Spain had seized Sardinia unopposed at the outbreak of war. She was forced to abandon both islands as one of the conditions of peace.*

The distinction between strategical and tactical defense, as we have appplied these terms to operations at sea, can well be illustrated by a reference to land operations. The campaign of 1866 in Bohemia affords a familiar example. Three German armies at the beginning of this campaign were assembling around Gorlitz in south Germany at a distance of 12 marches from Olmutz where the Austrian forces were assembling. Breslau, a Prussian city in Silesia, lay at a distance of 8 marches from Gorlitz and 6 marches from Olmutz. Thus the Austrian army

---

* Naval Warfare, pp. 327-330.



was nearer Breslau than were the German armies. Public opinion in Germany, as voiced by the Crown Prince, demanded that one of the German armies be sent to Breslau for the tactical defense of the city. Von Moltke advised strongly against the proposed movement on the ground that the presence of the three German armies at Gorlitz ready to march upon the Austrian army at Olmutz provided for the defense, strategically, of Breslau. He was overruled but it is easy to see that his judgment was correct. If the distance from Gorlitz to Breslau and Olmutz were 30 and 34 marches respectively, the distance from Breslau to Olmutz remaining unchanged (six marches), it is easy to see that the strategical defense of Breslau afforded by the three armies at Gorlitz would have been very imperfect. Tactical defense would have been essential, especially if Breslau had contained magazines of supplies that were necessary to the German armies at the end of the long march that they would have had to make to attack the Austrian army. The same would be true if Gorlitz and Olmutz were ports of rival nations where fleets were collected distant 34 days' sail from each other and Breslau were a naval station six days' sail from the enemy's coast. The necessity for a tactical defense of the naval station would be greater than the necessity for a similar defense of land magazines; for an army by a victory in the field can generally obtain needed supplies, while a victory in a fleet action on the enemy's coast cannot lead to the immediate capture of a well defended naval base thereon. If we suppose the base in the above illustration to have been insufficiently defended and to have fallen, a fleet victory would involve the crippling of certain of the victor's ships, and the towing, under proper escort, of these cripples to a distant home port. The enemy being near his own bases would soon repair his losses. Thus the victorious fleet would probably lose command of the sea within a few days after its victory. Far different would be the case if the victor had a well equipped naval station near at hand.

Hence the necessity for the tactical defense of a naval base near the enemy's coast.

We can easily apply these principles to the defense of Russia's Asiatic interests by the Russian fleet prior to 1904, and to our own defense of the Philippines. The Russians possessed a secure base at Vladivostok which needed no strategic naval defense. The Baltic, Port Arthur, and Vladivostok squadrons concentrated in Madagascar or in European waters would have prevented, by its strategic position, the invasion of the mainland of Asia and so would have averted war, unless the Japanese cons dered their fleet equal to a contest with the entire Russian navy, which is doubtful indeed. The fatuity of the Russians in dividing their forces equally between Europe and Asia and in further separating the Asiatic fleet into two squadrons, two little "fleets in being", needs no comment. A fleet at Honolulu or San Francisco or New York is powerless to protect strategically a naval station in the Philippines, if the station is not prepared to defend itself until the fleet arrives. On the other hand a fleet at any of these places could probably afford an effective strategic defense to the Philippine Islands if we had a well stocked, well equipped, and, above all, a well fortified, well garrisoned naval base awaiting its arrival in Far Eastern waters. We are led to believe that our fleet could arrive in excellent condition for immediate battle after its long voyage. But it is hardly credible that the enemy would give immediate battle. Could our fleet in the absence of facilities for docking and repairing ships, be kept many months in the tropics without having important vessels unfit for active service? The most serious question, however, would be what to do with the cripples after a hard sea fight. There appear to be three solutions to this question. 1. To tow the cripples 5,000 miles to Pearl Harbor. This would require a large naval escort and hence an inadmissible division of forces which would probably weaken the fleet to such an extent that the enemy would regain command of the sea. 2. To bring with the fleet on its outward voyage, floating docks and all the facilities to make repairs required after a great battle. The average speed of the *Dewey* on her trip to Manila was about 3.6 "miles" [illegible] hour. Had she been fitted with V-shaped or rounded en[illegible]owing she would probably have made about 6 "miles" [illegible]r.* 3. To intern disabled vessels in neutral ports. This would probably be more economical of fighting strength than to send escorts away from the theater of war on long voyages. We shall not attempt to make a decision amongst these possible courses of action. The adoption of any one of them or of a combination of them involves great sacrifices and gives us a measure of the necessity of having a defensible naval base in Philippine waters.

---

* The Vo[illegible] of the Dewey by Lieut. Commander F. M. Bennet, Proceedings of t[illegible]nited States Naval Institute, December, 1906, pp. 1165 and 1212, and [illegible]ating Drydocks, Anderson, pp. 79 and 131.

FLANK POSITIONS

As a companion to the delusions in regard to the necessity of capacious harbors for naval bases and the possibility of strategic defense of tactically indefensible bases, the use of "flank positions" for naval bases has many devotees. There is just enough truth in the arguments to make them dangerous. In his 63rd Tactical Problem Von Moltke gives a definition of a flank positon which, with a slight modification in terminology, will apply to naval warfare. "A flanking position is a position which is taken up near and parallel to the enemy's line of operation—a position which the enemy cannot pass without laying open his lines of communication."* The advantage of the flank position which England occupies with regard to the sea communications of Holland and Germany, either through the Channel or around the north of Scotland, is evident. Because of the great disadvantage under which their commerce labored the States General of Holland in the second war with the English prohibited "all subjects of the United Provinces to stir out of their ports upon pain of confiscation of their ships and merchandises,†" and they laid a similar embargo at the beginning of the third war. Eighty percent. of German tonnage is registered at the North Sea ports of Hamburg, Bremen and Bremerhaven and the war plans of Germany include an absolute cessation of transmarine commerce‡. Such are the advantages that England derives from her "flank position," which enables her fleets based upon her channel and North Sea ports to command the avenues of approach to the Dutch and German ports.

Fallacy enters when, from these solid grounds, it is asserted that fleets based upon naval bases flanking commercial routes command these routes more effectually than fortifications at narrow straits where these routes come to a focus. Thus it has been asserted and is widely believed that fleets based upon

---

* Tactical Problems, Von Moltke, Von Donat's Translation, p. 155.
† Naval Warfare, p. 46.
‡ The Admiralty of the Atlantic, Hislam, p. 97.

Aden and Malta would command the Red Sea route more effectually than fortifications on the Suez Canal; that a fleet based on Guantanamo is preferable to fortifications at the Panama Canal; and that a fleet based on Subic Bay is a better defense for Manila than a fleet based on any place in Manila Bay. Nothing makes more delicious reading than fallacies supported by skillful arguments. The fallacy in regard to the Suez and Panama Canals can be seen by considering the infinitely greater advantage that England would have over Holland and Germany if shoal water in the Straits of Dover and at the northern entrance to the North Sea compelled all shipping which enters the North Sea from the Atlantic to pass under the guns of fortresses on the English shore. It is interesting, too, to consider the effect on the naval situation in Europe that would be produced: (1) by narrowing the Strait of Gibraltar so that the guns of the fortress could command the strait; and (2) by moving Malta to the east and placing it so that British guns could command the entrance to the Suez Canal. We may rest assured that England has been restrained from fortifying the Suez Canal by other considerations than those arising from the advantages due to her possession of naval bases flanking the Red Sea Route. These naval bases are innocuous unless fleets are based upon them capable of commanding the adjacent seas. But it is not necessary to take supposititious cases. The Russian Black Sea Fleet is confined to the Black Sea by the Turkish forts on the Dardanelles and no fleet can enter the Black Sea without permission from the Turk.*

GUANTANAMO AS A FLANK POSITION FOR THE DEFENSE OF THE PANAMA CANAL

In regard to the defense of the Panama Canal†, it should be noted that both Guantanamo and a fortress at the Canal itself are on the mainland in the sense in which we have used that term in the preceding pages. Either place will therefore require a large garrison in the absence of the fleet. A superior fleet based upon Guantanamo would serve two purposes: (1) It would prevent the use of the canal by the enemy's naval forces and commercial shipping. Fortifications at the canal would accomplish the same purpose without the presence of naval vessels. Guantanamo would be harmless to the enemy if a fleet were not kept in the Carribean. (2) It would keep the trade routes in the Carribean open for our shipping. Fortifications at the canal could not do this, but a fleet based upon a naval station at the canal would keep the trade routes open both in the Carribean and the Pacific. Moreover, a fortress on the canal will possess an advantage over Guantanamo and every other naval station abroad in the ease with which reinforcements and supplies can be sent to it. It is inconceivable that the enemy, as long as the canal remains in our hands, will be able to command both the Atlantic and the Pacific at the same time. We shall therefore be at liberty to send men and supplies by at least one route at all times, and either route to the canal is much shorter than that of any other first class power to the canal. It should be remembered, too, that we shall have to maintain a large military force in the Zone in time of war to prevent the obstruction of the canal and that this force will provide for the security of a naval base in the Zone. What surer retreat could there be for a fleet than that of passing through the canal from the Atlantic to the Pacific, or *vice versa*? What place can furnish a more ideal naval base abroad than one of the basins along the Panama Canal?

---

* International Law, Oppenheim, Vol. 1, p. 251.

† No attempt is here made to discuss the question of the defense of the Panama Canal from the point of view of International Law. It has been assumed that the United States has a right to erect fortifications at the canal and to employ her land and naval forces for the safety and protection of the canal because of the express stipulation to that effect in the treaty with Panama signed November 8, 1903; and, also, because the clause in the Clayton-Bulwer Treaty prohibiting fortifications was left out of the last treaty with Great Britain. It has been assumed that fortifications at the canal could lawfully prevent the use of the canal by the enemy's shipping because of the accepted views of writers on International Law on the rights of territorial powers over narrow straits. The following is from an English writer: "These instances" [arrangements made with Denmark by

SUBIC BAY AS A FLANK POSITION FOR THE DEFENSE OF MANILA

With reference to the defense of Manila by a fleet based on Subic Bay it has been asserted: (1) that as Subic Bay lies upon the flank of the enemy's advance upon Manila it will be of great value as a port of sortie for an inferior naval force to issue and harass the enemy's fleet, which would have to be more

---

the certain powers to secure free passage of the sound] "show that the common law of nations now imposes upon all maritime powers the duty of allowing a free passage through such of their territorial waters as are channels of communications between two portions of the high seas. *The right thus created is, of course, confined to vessels of states at peace with the territorial power, and is conditional upon the observance of reasonable regulations and the performance of no unlawful acts. It extends to vessels of war as well as to merchant vessels.*" *The Principles of International Law, Lawrnece, Third Edition, 1907, p. 178.* If such are the rights of territorial powers over natural channels, how much greater are those rights where a channel has been made by a state at an enormous expense.

than twice our strength before he could attack Manila without first disposing of our fleet in Subic Bay; and (2) that with the fleet based upon Manila Bay, an attack upon Manila would also be an attack upon the fleet. These arguments are founded upon the supposition that our government would allow an inferior fleet to be blockaded in a naval base in order to defend the base. This has been a favorite practice with the Mediterranean nations which for four hundred years have been building fleets for the Anglo-Saxon nations to destroy, but it is a non-Anglo-Saxon practice. Byng would not have taken refuge in Port Mahon after his defeat, even if he could have done so. In 1812 our little navy boldly took the sea in the face of a superior fleet; in 1898 when Camara started on his dash for Manila* and again in 1907 our government showed that it would not sacrifice its chance of ultimate victory by letting its war vessels, fit-to-lie-in-a-line, be blockaded either in Manila or Subic Bays. It must be evident to the most casual observer that if our fleet in the Philippines is superior to the enemy's fleet, it is immaterial, as far as the defense of Manila is concerned, whether it is based on Subic Bay or Manila Bay. The value of Subic Bay as a flank position therefore rests upon a use of the fleet which is inconsistent with correct military principles, the traditions of our race, and our settled naval policy.

The control, by seagoing fleets based upon flank positions, of routes that come to a focus has much in common with the discarded policy formerly pursued by the United States, France and Germany, of providing for the local defense of seaports by special harbor defense vessels. Both require the assignment of naval vessels to particular localities. The death knell of the harbor defense monitor struck in 1898, when our monitors, instead of lying behind submarine mine fields, like the German navy of 1870,† waiting for the Spanish to attack them and get blown up, sallied forth to reinforce the seagoing fleet, in spite of their slow speed, low freeboards, and unstable gun platforms. The fallacy in the flank position theory is exposed today by the withdrawal of vessels from the British Mediterranean fleet to reinforce the Channel and Home Squadrons.

Happily our government now resolutely sets its face against assigning vessels of any type to the permanent defense of particular localities. ‡ The Napoleonic-Nelsonian theory of concentration for vigorous offensive battle is utterly at variance with the assignment of special vessels for the defense of seaports, of one "fleet in being" to Guantanamo to defend the Panama Canal, and of another to Subic Bay to defend the Philippine Naval Base. Deficient tactical defense for naval bases reacts unfavorably upon the war fleet, which in all its movements should be free from any responsibility for the mere safety of the port it quits.* Proper tactical defense for these bases which are the true and necessary complement of an efficient navy, releases the navy for its proper work,-- offensive upon the open seas, or off the enemy's shores.† "Seaports cannot strike beyond the range of their guns; but if the great commercial ports and naval stations can strike effectively so far [and are secure against land attack], the fleet can launch into the deep, rejoicing, knowing that its home interests, behind the buckler of the fixed defenses, are still safe till it returns."‡

---

* Lessons of the War with Spain, p. 34.

† The Admiralty of the Atlantic, p. 8.

‡ President Roosevelt, Annual Message, December 3, 1907, F. R. U. S., 1907, Vol. 1, p. LVII.

CONCLUSION

We conclude that an indispensable requirement for a naval base, which shall be an element of strength instead of weakness, is that its own inherent strength and susceptibility for defense shall be such that a relatively small garrison may render it impregnable by land and sea, so that it shall not be dependent upon the fleet for protection but only for supplies and reinforcements at long intervals. Sound military policy demands that these permanent stations shall be few in number, strongly fortified and garrisoned, and well provided with ammunition and stores and facilities for refitment and repair. Inherent strength cannot give importance to a place without strategic value; but a place without inherent strength can have no strategic value for permanent occupation.

Secure anchorages but not capacious harbors are needed for distant naval bases. Such bases are not used by superior fleets as places of refuge, and should not thus be used by inferior fleets. Finally, the abandonment of indefensible bases, should not be postponed until foreign relations become unfriendly. Half measures keep the country in a chronic state of unpreparedness for war. Such measures give foreign nations great advantages when diplomatic relations become strained; they compel the government to assume an humble tone, even toward weaker states; and, when war supervenes, they lead to disaster.

---

* Lessons of the War with Spain, p. 56.

† Ibid, p. 58.

‡ Ibid, p. 63.

INVESTIGATION OF GASOLENE ENGINES WITH A VIEW TO DETERMINING THEIR SUITABILITY AS A SOURCE OF POWER FOR COAST DEFENSE INSTALLATIONS

BY CAPTAINS JOHN O. STEGER AND FRANK T. HINES, C. A. C.

Approved Solution, Advanced Course, Department of Engineering and Mine Defense, Coast Artillery School

---

PROBLEM NO. 2.

Investigate gasolene engines with a view to determining their suitability as a source of power for coast defense installations.

This study will include:

1. The principles of their operation.
2. The comparative advantages and disadvantages of two-cycle and four-cycle engines.
3. The relative merits of two-, four-, five-, six-, etc., cylinder engines.
4. Carburetors.
5. Ignition systems.
6. Cooling systems.
7. Lubricating systems and lubricants.
8. Starting devices.
9. Speed regulation.
10. Advantages and disadvantages of high, as compared with low, speed engines.
11. Ratio of weight to rating.
12. A statement of the features you recommend for incorporation into a service engine, with reasons.
13. The following gasolene engines at the post will be examined and operated:—
    a. Twenty-five k.w. General Electric Co. gas-motor set.
    b. Six and a half k.w. General Electric Co. gas-motor set.
    c. The Standard engine in the distribution-box boat. This will include an hour's run about the bay.
    d. The speedway engine in the Q.M. launch. This will include an hour's run about the bay.

e. The Cushman engine belonging to the air-compressor set.

14. A test will be made of a designated engine following the method recommended by the American Society of Mechanical Engineers.

The object of the test will be as follows:—

a. To determine whether the set can fulfill its contract guaranties.
b. To determine the full load and 25% overload efficiency of the set.
c. To determine the cost of electrical energy at the switchboard.
d. To determine whether the set is adapted for service use with a statement of the installations for which it is suited.
e. Determine heat balances and electrical losses.

Note:—Gasolene costs 12½ cents per gallon. Cylinder oil costs 65 cents per gallon.

GASOLENE ENGINES

1. PRINCIPLES OF THEIR OPERATION

The gas engine belongs to that class of engines which use as their working fluid a gas obtained by the proper mixing of gasolene vapor with air. They are further classified as heat engines, the work being produced by a change of temperature of the gases as well as by a change of pressure.

In mechanical construction they are of the reciprocating type, both single- and double-acting.

The heat available for use is produced by the combustion of gas in the working cylinders at the proper time, hence the term "internal combustion engine".

The principles of operation of the several types of gasolene engines is practically the same, and briefly consist of one or more cylinders, usually not exceeding six, containing a piston which is moved by the pressure produced by the explosion and combustion of a charge of gasolene vapor and air.

The motion of the piston is communicated to a main shaft by a connecting rod similar to those used in the steam engine. A valve mechanism is provided to admit and exhaust the charge at the proper interval and is operated by a system of cams geared to the engine itself.

The explosion in the cylinder can only occur after the mixture has been drawn into the cylinder and so prepared that it ignites quickly and burns completely. Another explosion can not take place until the useless products of combustion have been expelled and the cylinder made ready for a fresh charge. These events are called a cycle.

The internal combustion engine most commonly found in use requires four strokes for one cycle of operation, and is termed the "four-(stroke) cycle engine." An example being the 25 k.w. gas-motor set, made by the General Electric Co.

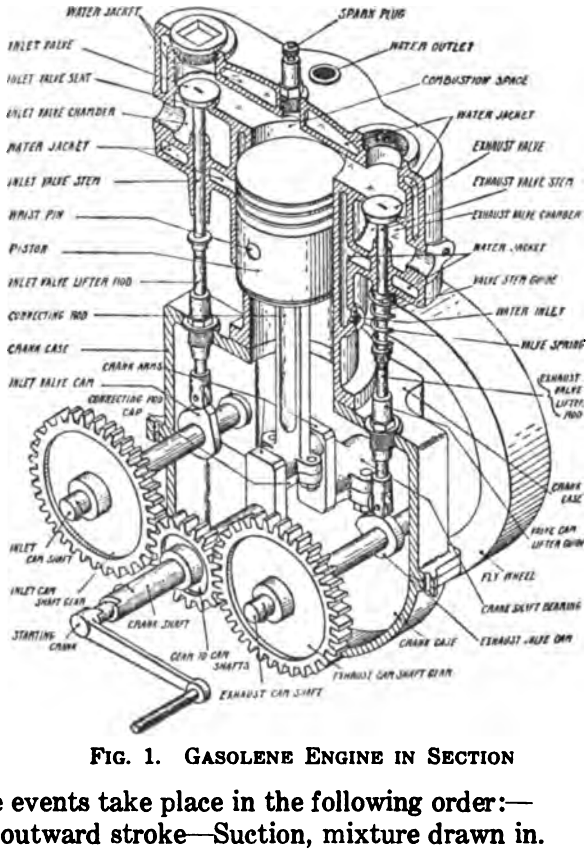


FIG. 1. GASOLENE ENGINE IN SECTION

The events take place in the following order:—
1st outward stroke—Suction, mixture drawn in.
1st inward stroke—Compression, charge is compressed.
2nd outward stroke—Explosion, combustion and expansion.
2nd inward stroke—Exhaust, products of combustion are expelled.

These events are diagrammatically shown in figures 1 and 2.*

---

* Figures 1, 2, 3, 4, 6, 7, and 9, are reproduced from Whitman's "Motor-Car Principles." Copyright, 1907, 1909, by D. Appleton and Company.

When the operations described above are preformed in two instead of four strokes, the engine is termed a "two-(stroke) cycle engine." This necessarily makes the engine in part double-acting, as both sides of the piston operate in closed chambers. The crank case is made tight by using stuffing boxes on the main shaft. In this case the events take place as follows:—

Inward stroke—Suction in crank case; compression an explosion in working cylinder.

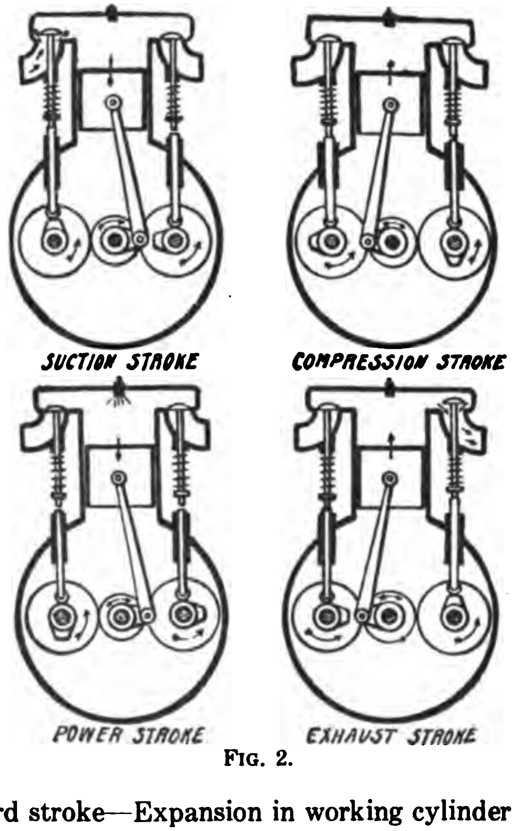

SUCTION STROKE
COMPRESSION STROKE
POWER STROKE
EXHAUST STROKE

Fig. 2.

Outward stroke—Expansion in working cylinder and partial compression in crank case.

These events are diagrammatically shown in Fig. 3.

The essential difference between the method of operation of the two- and four-cycle engines is that the exhaust and charging actions of the four-cycle are done in another way in the two-cycle engine, and therefore the crank receives an impulse every revolution instead of every other one.

2. THE COMPARATIVE ADVANTAGES AND DISADVANTAGES OF TWO-CYCLE AND FOUR-CYCLE ENGINES

In the four-cycle engine each of the events occurs separately during practically an entire piston stroke, while in the two-cycle engine at least two of them must be restricted to considerable less time: these two are suction and exhaust.

Suction, occurring while the exhaust port is open, necessitates rapid scavenging of the cylinder of the useless products of combustion. This is the greatest disadvantage of the two-cycle engine, scavenging being quite incomplete at speeds above 600 r. p. m., which also results in a poor charge and inefficiency.

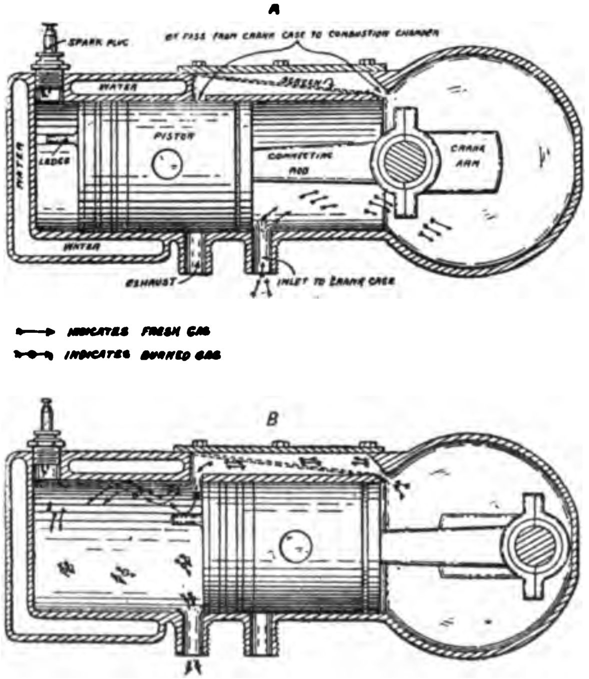


FIG. 3. TWO-CYCLE ENGINE

Combustion, depending on the composition of the charge, is seriously affected by the above cause. Incomplete combustion sometimes produces after-burning, which has bad effect upon expansion.

The other points to be considered are:—

Power distribution,
Regulation,
Simplicity and adjustment,
Weight and size.

Power.—The two-cycle engine gives one power-stroke per cylinder per revolution against one in two revolutions for the four-cycle, resulting in better power distribution and speed regulation, both within the limits of speed for efficient suction and exhaust, about 600 r.p.m.

In *simplicity* and *adjustments* the two-cycle has great advantages as the valves and valve mechanism are not required.

In *weight* and *size* per h.p., the two-cycle engine has an apparent advantage owing to the deliverance of power once each revolution. This is more or less offset, however, by the speed limit of this type and by the double-acting cylinders in large four-cycle engines.

For the above reasons the two-cycle engine is much used in small sizes. Inefficiency, due to poor scavenging prevents its general use for high powers and speeds.

3. RELATIVE MERITS OF TWO-, THREE-, FOUR-, FIVE-, SIX-, ETC., CYLINDER ENGINES

Two-cylinder.—Two-cylinder engines may be arranged in three ways:

1. 360° crank shaft.
2. 180° crank shaft.
3. Horizontal double opposed.

1. 360° Crank Shaft.—The pistons move up and down together, delivering power once each revolution. The mechanical balance of this type is very poor. (See Fig. 4.)

2. 180° Crank Shaft.—The pistons move in opposite directions resulting in two power-strokes during one revolution and none during the next, the distribution of power is poor. (See Fig. 4.)

3. Horizontal double opposed.—The pistons are on opposite sides of the crank-shaft and move in opposite directions. Power may be delivered once each revolution and the mechanical balance is good. This type occupies more space than the other two. (See Fig. 4.) Two-cylinder engines require a heavy fly-wheel to carry the piston over two dead strokes during each cycle.

Three-cylinder.—Three-cylinder engines are built with 120° crank-shafts, producing three power-strokes during two revolutions. They have excellent mechanical balance. Although the cost and difficulty of manufacture of this type of crank-shaft limits the production, they are quite extensively used for high-speed marine engines of small power, about 18 to 35 H.P.

Note:—Both the two- and three-cylinder engines require a heavy fly-wheel to carry the piston over dead strokes.

Four-cylinder.—Four-cylinder engines give two strokes per revolution with no dead strokes; they require a small fly-wheel for speed regulation. Fig. 4 shows the type of crank-shaft now in general use, the cylinders firing in the following order: 1, 2, 4, 3. It has been suggested that the following firing order reduces strains and vibration, 1, 3, 4, 2.

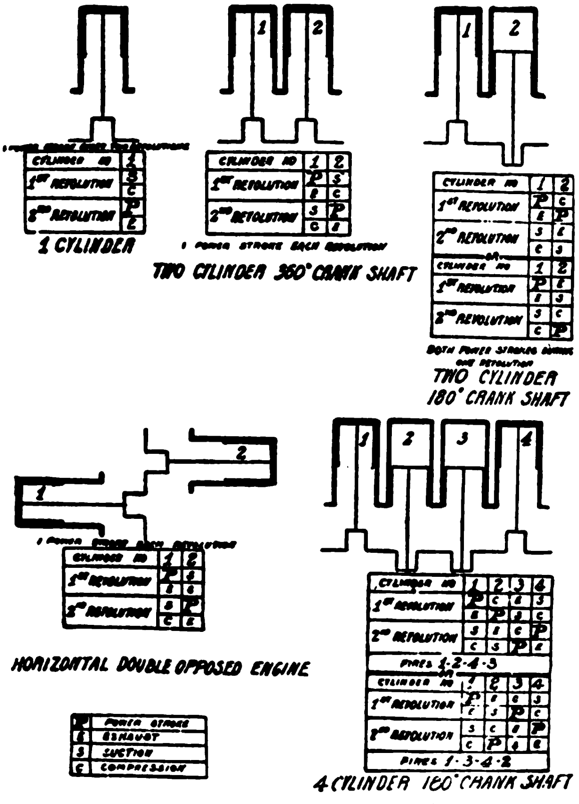

1 POWER STROKE EACH REVOLUTION
1 CYLINDER
1 POWER STROKE EACH REVOLUTION
TWO CYLINDER 360° CRANK SHAFT
BOTH POWER STROKES DURING ONE REVOLUTION
TWO CYLINDER 180° CRANK SHAFT
1 POWER STROKE EACH REVOLUTION
HORIZONTAL DOUBLE OPPOSED ENGINE
FIRES 1-2-4-3
FIRES 1-3-4-2
4 CYLINDER 180° CRANK SHAFT
P POWER STROKE
E EXHAUST
S SUCTION
C COMPRESSION

FIG. 4. ENGINE ARRANGEMENTS SHOWING ORDER OF FIRING

Five-cylinder.—Five-cylinder engines should give better power distribution than the four-cylinder type, but do not appear to be manufactured for the trade, probably due to the difficulty of making the crank-shaft with cranks 72° apart.

Six-cylinder.—Six-cylinder engines are built with 120° crank-shafts, and produce six power-strokes during two revolutions, with the best balance possible to obtain, without an excessive number of cylinders. It will be seen that one power-stroke commences when the previous one is ⅔ completed, resulting in steady application of power and smooth running at greatly varying speeds.

The best type of engine depends upon the demands to be made upon it, the care it will receive, and the knowledge of the operator.

The greater the number of cylinders the more steadily is the power applied and the more easily is the speed regulated.

The complication of parts, attention and knowledge of operator required, are disadvantages in engines containing six or more cylinders.

4. CARBURETORS

Carburetors are devices for mixing air and gasolene in proper proportion to form an explosive. This is accomplished in two ways, first by passing air over or through the gasolene, which results in the bubbling or surface types, and second by spraying gasolene into the current of incoming air, known as the spray, or jet, type.

The spray type seems to be in general use, and is made in constant level, gravity, and pressure-feed systems. The constant level of gasolene is maintained just below the end of jet by a float or overflow pipe. The gasolene may be fed by gravity from a tank located above the carburetor, or by pressure either of air, gases, or pump.

All of the above systems are more or less in use. In traction motors the float feed has been generally adopted, though the gravity feed is largely used in marine engines. The overflow type seems to find favor in stationary engines of moderate power, while the pressure-feed is used in large units.

Many types of carburetors are on the market, but the underlying principles of them all are based on the three methods described, or combinations of them.

The use of exhaust gases and artificial heat are frequently resorted to, in order to quicken vaporization in cold weather.

"The evaporation of gasolene at atmospheric pressure varies approximately as the relative squares of the temperatures, so that in summer with a temperature of 80° F., the evaporation may be four times greater than in winter at a temperature of 40° F. Hence a carburetor may do very much more work in summer than in winter." (Page 76, Gas, Gasolene, and Oil Engines, Hiscox.)

Carburetors on the engines operated under section 13 of the problem were designed to admit varying quantities of hot air (from crank case or from around the outside of exhaust pipe) and air at atmospheric temperature. In one case an extra air valve had been installed by local labor between the carburetor and cylinder, and in another an auxiliary air valve, separate and distinct from the carburetor, admitted air at atmospheric temperature with each charge.

5. IGNITION SYSTEMS

The electric spark is universally used to ignite the explosive mixture in gasolene engines. The spark may be formed in one of two ways:—

1. Make and break system.
2. Jump spark system.

1. *Make and break system.*—In this system the igniter which is the device at which the spark occurs in the cylinder, consists of a stationary and a moveable point. These points are brought into contact and separated at the proper time by cam and spring action, breaking a low tension inductive electric circuit and causing a spark to bridge the gap formed.

The induction of the circuit is made high by means of a "primary induction coil." The spark is timed by changing the cam position.

2. *Jump spark system.*—The spark is made to jump a permanent gap in the igniter by passing a high-tension electric current through the circuit. The high tension is formed by means of a "secondary induction coil", actuated by a low-tension current in the primary circuit.

The system requires in the primary circuit a timer, vibrator and a condenser in parallel with the latter; in the secondary circuit a spark plug, and a distributer where one coil supplies several cylinders.

The timer is a very important part of the jump-spark system, its function is to make and break the primary circuit at the proper time.

There are numerous types of timers but their principles of operation are fundamentally the same. A half-time shaft actuates a cam wiper inside of a case, and at the proper time makes and breaks contact with insulated terminals. The number of such terminals depends upon the number of cylinders.

The vibrator.—The function of the vibrator is to give a series of sparks, instead of a single spark, at the igniter, and thus insure ignition of the charge. The vibration of the armature of the vibrator coil makes and breaks the primary circuit rapidly, causing a pulsating current of increased pressure in the secondary circuit.

The condenser.—A condenser is placed in parallel with the vibrator to prevent excessive sparking at the contact points.

The spark plug.—This is the device in the combustion space at which the spark occurs. It consists of insulated and grounded electrodes separated by an air gap of the proper length across which the spark is produced. (See Fig. 5.)*

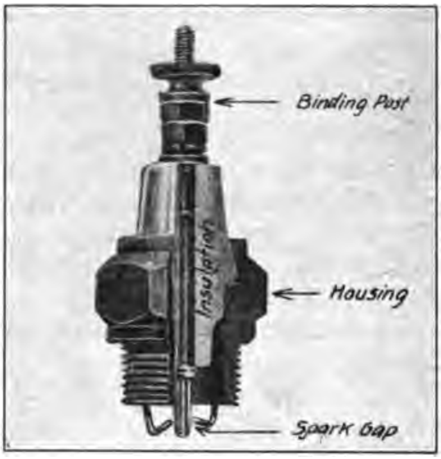


Fig. 5.

The distributor.—The function of the distributor when used in connection with the coil and battery system is to synchronize the firing of the different cylinders, and to obviate the necessity of having a separate coil for each cylinder of a multi-cylinder engine. In some high-tension magneto-machines, it is mounted as part of the magneto-machine, and, while synchronizing with the action of the contact breaker, distributes the high-tension circuit to the various cylinders.

The source of electricity in either system may be a primary battery, storage battery, or magneto. When the latter is used one of the former is usually necessary for starting the engine.

A safety spark-gap is sometimes installed in parallel with the spark-coil where magneto is used, to give a path for the current in case a leak develops in the secondary circuit.

The jump-spark systems are high-tension, but may have either high-, or low-tension magnetos as part of same. With the low tension magneto it is necessary to use the ordinary secondary spark coil, while the high-tension magneto embodies the secondary winding and the condenser.

---

* Figs. 5, 8 and 11 are reproduced from catalog of the Bosch Magneto Company.

The two systems referred to above are shown diagrammatically in Figs. 6 and 7.

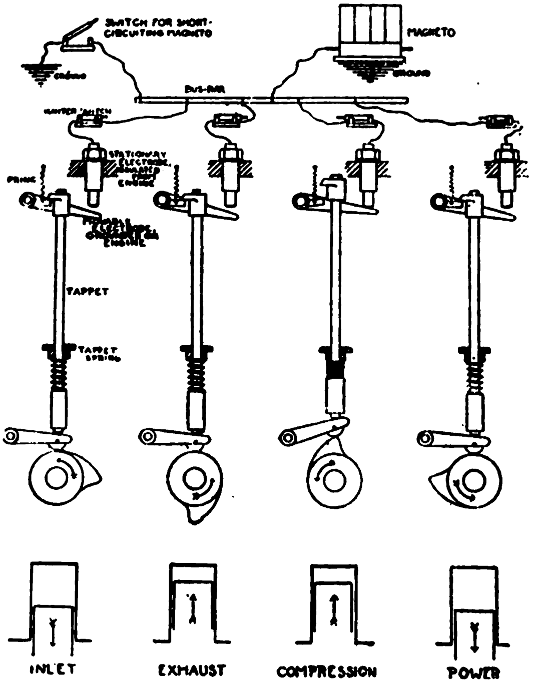

SWITCH FOR SHORT-CIRCUITING MAGNETO
GROUND
MAGNETO
GROUND
BUS-BAR
IGNITER SWITCH
STATIONARY ELECTRODE, INSULATED FROM ENGINE
SPRING
MOVABLE ELECTRODE, GROUNDED ON ENGINE
TAPPET
TAPPET SPRING
INLET
EXHAUST
COMPRESSION
POWER

FIG. 6. MAKE AND BREAK SYSTEM

The Eisemann low-tension ignition system.—This system is shown diagrammatically in Figs. 8 and 9.

The magneto is of the usual type, but the winding is so proportioned that the current is of lower voltage than is usually delivered by the usual type of low-tension magneto. One end of the winding is grounded on the metal of the armature and the other end is connected to a contact screw.

The current flows to this screw and from there two paths are presented by which it may flow back and complete the circuit. One of these paths leads through the primary winding of a secondary coil, and the other through a lever that, for the greater part of the revolution of the armature, touches the contact screw.

The lever is grounded on the metal of the magneto, and when it touches the contact the circuit that is then completed is short

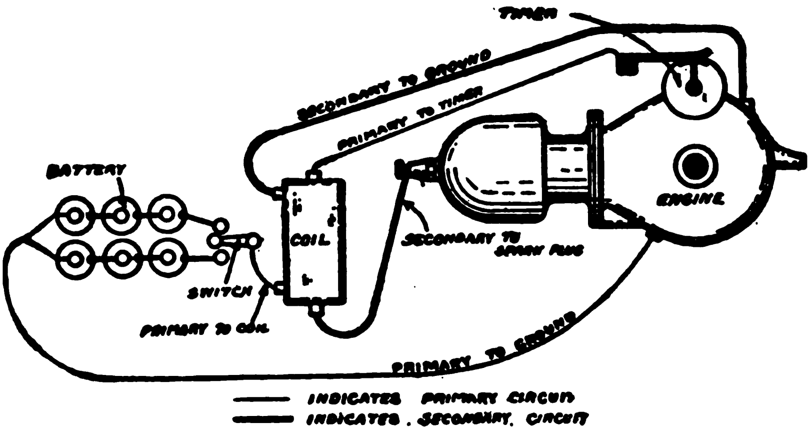


FIG. 7. IGNITION CIRCUIT

Wiring diagram for one-cylinder engine, with coil, timer, and two batteries; coil with magnetic vibrator

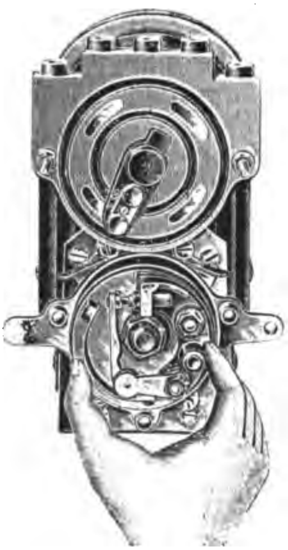


FIG. 8.

Front view; make and break cover detached

and of low resistance and the current follows it in preference to the circuit of higher resistance through the primary winding of the coil. The circuit is then from armature to contact screw, which is insulated from the magneto, to lever, and then by ground back to armature.

A cam with two projections, is attached to the armature shaft in such position that it operates the lever, by moving it away from the contact screw.

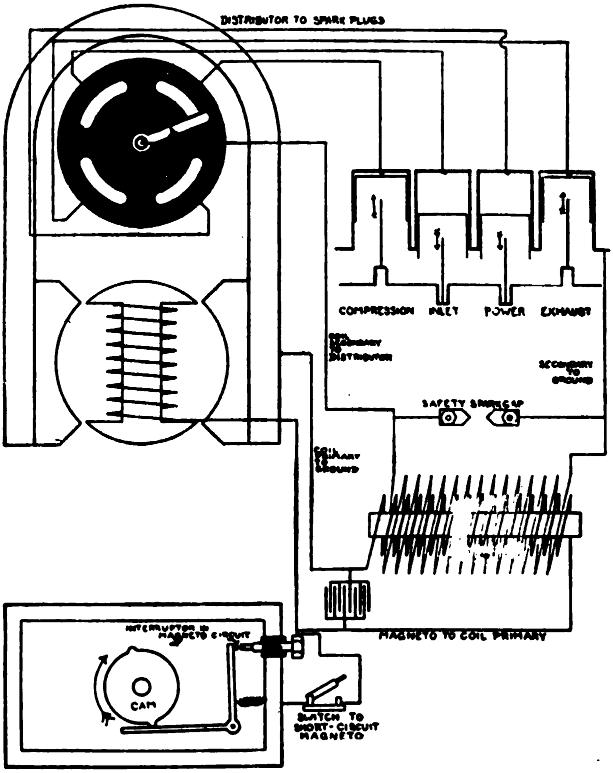

DISTRIBUTOR TO SPARK PLUGS
COMPRESSION
INLET
POWER
EXHAUST
COIL SECONDARY TO DISTRIBUTOR
SECONDARY TO GROUND
SAFETY SPARK GAP
COIL PRIMARY TO GROUND
INTERRUPTOR IN MAGNETO CIRCUIT
MAGNETO TO COIL PRIMARY
CAM
SWITCH TO SHORT-CIRCUIT MAGNETO

FIG. 9. EISEMANN IGNITION SYSTEM

This arrangement is called the interruptor and by its operation it closes and opens the low-resistance circuit by which the magneto current may flow.

When the armature is horizontal, and during the time it is approaching the vertical, the circuit is closed through the interrupter, but when the armature reaches the position in which it gives its maximum current, the interrupter is opened by the cam and the current losing its low-resistance circuit, is caused to flow through the primary winding of the induction coil. The sudden flow of current through the primary winding induces a strong current in the secondary and ignites the charge.

The magneto current is at its maximum twice during each revolution of the armature, so the cam is arranged to open the low-resistance circuit at such periods that each maximum is required to flow through the primary of the induction coil.

The advantages and disadvantages of the two systems are:—

Make-and-break ignition.—Low-tension, requiring less thorough insulation, and causing less short-circuit troubles. Electrically more simple and mechanically more complex than the jump-spark system. The former presents some difficulty in applying it to high-speed engines. Rapid wear and fouling of parts.

Jump-spark ignition.—Electrically more complex than the make-and-break, but, having no moving parts inside of the cylinder, is mechanically better.

Adaptable to very high speeds, and has great flexibility of spark adjustment.

6. COOLING SYSTEMS

Cooling systems may be classified into water-cooling and air-cooling systems, and combinations of the two.

Water-cooling systems cause a circulation of water around the jacket and other parts to be cooled, either by convection, gravity, or by pump pressure.

The same water may be used repeatedly, in which case it is cooled between leaving and entering the jacket, or a fresh supply is continuously forced through the system. The water, in the former case, is usually cooled by means of a fan, which causes air to impinge upon a system of baffled pipes through which the heated water must pass.

In air-cooling systems the jacket is made so that a greater surface is exposed to the air, usually the surface is baffled and the air forced by a fan against the cooling surface.

The water-cooling, or combined, system seems to be in general use, depending upon what use is made of the engine and the facility with which an abundant water supply is obtained, and the cost.

7. LUBRICANTS AND LUBRICATING SYSTEMS

Lubricants.—The following is a classification of the most commonly used lubricants:—

Liquids.—

1. Animal oils: Lard and lard oil, Neatsfoot, Tallow and tallow oil, Sperm, Whale.	Possess greater body than mineral oils, but are unstable, especially at cylinder temperatures, forming corrosive acids.
2. Vegetable oils: Linseed, (Dries at ord. temperature.) Castor, Cottonseed, (Partial drying.) Olive, Palm, (Non drying.) Rapeseed.	Possess greater body than mineral oils, but decompose at low temperatures, forming corrosive acids and causing gumming. Spontaneous combustion.
3. Mineral oils: Distilled, Natural, Refined.	Cover greater range of fluidity than others, are more stable. Do not acidify even with time, but lack body for heavy work. Are somewhat volatile.
4. Compounds of the above.	

Solids.—Graphite, soapstone, and powdered mica, combined with a grease will stand pressures that no liquid will bear, but the coefficient of friction is high and their use should be avoided where practicable.

Greases.—Oils and fats thickened with soap. For extra heavy pressures the above solids may be mixed with grease. For engine oil the soap used is tallow, lard oil, or caustic soda.

Qualifications of good lubricants:—

1. Sufficient "body" to prevent the surfaces from coming into contact under conditions of maximum pressure.
2. Capacity for absorbing and carrying away heat.
3. Low coefficient of friction.
4. Maximum fluidity consistent with the "body" required.
5. Freedom from any tendency to oxidize, or gum.
6. A high "flash point" or temperature of vaporization and a low congealing or "freezing point."
7. Freedom from corrosive acids of either metallic or animal origin.

Mineral oils have a greater range of fluidity, are free from tendency to oxidize, and do not decompose, or form corrosive acids. They are inferior to animal oils in body and also, to a less extent, to vegetable oils. They also vaporize at lower temperatures. Animal and vegetable oils are subject to spontaneous combustion. They deteriorate on exposure to air, and do not admit of repeated use in flooding systems

Compounds of the three classes are now made which possess the most desired qualities of each, and, if properly prepared for the use to which put, are superior lubricants.

Lubricating Systems.—

Bearings.—Bearings may be lubricated in the following ways:

1. Intermittent applications by hand are limited to small parts of light pressure which do not easily admit of oil cups, etc.

2. The majority of lubrication is by oil cups, filled by hand at intervals, the oil being fed by drops, according to requirements.

3. In large plants the principal parts are supplied with a continuous flow of oil which floods the rubbing surfaces. The oil is forced to the parts by gravity, pressure, or pump. The oil is usually collected, filtered and used again.

Under heading 2, there are many types of oilers in use; the oil cup, dropping, or wipe, feed, the telescopic oiler, the ring and reservoir system, wick and reservoir system, centrifugal oilers, pendulum oilers, and splash oiling, in which the connecting rods dip into oil once each revolution and splash the cylinder and parts.

Under heading 3, there are: gravity oil feed, low-pressure, gravity, or constant-level oil feed, compressed air feed, and pump feed.

Cylinders may be lubricated by:—

1. Splash system, in which the crank case is filled with oil to such a point that the end of connecting rod dips into it each revolution, and splashes the oil to all parts of the crank case, and a portion is caught in a narrow groove around the lower end of the piston and spread on the cylinder walls during the inward piston stroke.

Constant level is maintained by replacing used oil by a lubricator operated by gravity, by pump, or pressure maintained in oil tank.

2. Mechanically operated lubricators, in which oil is supplied, usually by gravity, from constant level cups, kept filled by periodic oilers of some sort.

3. Pressure lubricators, which supply oil to all engine parts by means of pump, air, or gas, pressure, each passage being adjustable.

[The table on next page is from *Power*, Dec. 1905, p. 750.]

PHYSICAL CHARACTERISTICS OF A NUMBER OF LUBRICANTS

Kind of Oil	Use and Adaption.	Gravity. °	Cold Test. °	Flash Test. °	Fire Test. °	Viscosity at 70°.
High pressure cylinder oil.	For steam cylinders using dry steam from 110 to 210 lbs. pressure.	25 to 24.5	30	600 to 610	645 to 660	175 to 205
General cylinder oil.	For steam cylinders using dry steam at 75 to 100 lbs. For air compressor cylinders when made from steam refined mineral stock and when viscosity is 200.	26 to 25.5	30	550 to 585	600 to 630	180 to 190
Wet cylinder oil. (Remark 1.)	For use where the steam is moist, especially in compound and triple expansion engines.	25.8 to 25.3	30	560 to 585	600 to 630	150 to 185
Gas engine cylinder oil. (Remark 2.)	For gas engine cylinders. Neutral mineral oil compounded with an insoluble soap to give body.	26.5	30	320	350	300
Automobile gas engine oil. (Remark 3.)	For automobile gas engines and similar work.	29.5	30	430	485	195
Heavy engine and machinery oils.	For heavy slides and bearings, shafting, and horizontal surfaces.	30.5 to 29.5	30	400	440 to 450	170 to 195
General engine and machine oils.	For high-speed dynamos and machines.	30.8 to 30	30	400 to 420	450 to 470	175 to 190
Fine and light machine oils.	For fine work, from printing presses to sewing machines and typewriter oils. Excellent spindle oil, with cold test of 25° to 28°, and viscosity of 140°.	32.5 to 30.2	30	400	440	110 to 160
Cutting and heat dissipating oils. (Remark 4.)	For cutting tools, screw cutting and similar work.	27 to 23	30	410 to 420	475 to 480	210 to 175
Refrigerating oils.	For ice machinery.	30.2	0	200	225	165
Wet service and marine oils. (Remark 4.)	For marine service, or where much moisture must be handled.	28	30	430	475	230
Greases	They are used in special work and for heavy pressures moving at slow velocities.					

Remark 1.—May contain not over 2 to 6 per cent of refined acidless tallow oil in the high-pressure oils and not over 6 to 12 per cent in the low-pressure oils.

Remark 2.—The reason for using an insoluble soap such as oleate of aluminum is that it is impossible to decompose the soap with a high heat; the soap, although not a lubricant, is a vehicle for carrying some oil.

Remark 3.—Owing to a lack of body, this oil will not interfere with the sparking by depositing carbon on the platinum point.

Remark 4.—May contain 30 to 40 per cent of pure strained lard oil.

8. STARTING DEVICES

The various methods of starting are as follows:—

1. By cranking. a. By hand. b. By crank.
2. Starting by smaller engine or some other source of power.
3. Compressed air.
4. Electric starters.
5. Starting cartridge.

1. Cranking by hand is the best method of starting small engines up to 10 or 12 H.P. From 12 to 20 H.P., it is necessary to use the starting crank.

2. Starting by use of smaller engine is accomplished in plants using other engines, by transmitting the motion of a main shaft to the fly-wheel of the gas engine, or in large installations having a smaller engine geared to a shaft which is made to mesh into a ring of teeth on the fly-wheel of the gas engine, and is then automatically thrown out of mesh when the start is made.

These methods are neither economical, or convenient, and are being displaced by the use of compressed air.

3. The use of compressed air for starting is suitable for any size of gas engine. The pressure required varies from 100 to 150 lbs. per square inch. The method of starting is to set the engine beyond the center and then give an impulse through the starting valve.

4. Starting by electricity is sometimes used in localities where electric current is available. It can be accomplished in two ways:

a. If gas engine is directly connected to a dynamo, by running the dynamo as a motor.

b. By using a separate motor geared to the fly-wheel.

5. The starting cartridge can be used successfully on gas engines as high as 50 H.P., but due to fouling of the cylinder, their use is not recommended. The device consists of a suitable breech-block inserted in the top of the cylinder of the engine, in which is placed a standard 10- or 12-gauge cartridge. The cartridge is fired by striking the firing pin with the palm of the hand.

9. SPEED REGULATION

1. The speed regulation of all types of gasolene engines examined was found to be made in two ways, viz: By the use of heavy fly-wheels and some form of governor. The fly-wheel, within allowable limits, tends to eliminate the variations in speed due to the impulse of explosion. The methods of goverinng in use come under some one of the following heads:—

a. The hit-and-miss system.

b. Variation of the ratio of fuel to air with change in load; quality governing.

c. Variation of the quantity of the charge to suit the load, ratio of fuel to air remaining constant, quantity governing.

d. Combination system.

e. Governing by varying the time of ignition.

a. This method regulates the speed by cutting out explosions. That is, the governor prevents the drawing in of the "next charge," and consequently causes a "miss." This miss will so reduce the speed as to cause the governor to act in the opposite direction and cause the explosions to recur, thus making a "hit".

Mechanically these results are obtained by closing the fuel valve; or closing the inlet valve. This method is not suitable for close regulation, is economical in the use of fuel, but has mechanical disadvantages.

b. Under this method the governor acts on the fuel-admission valve and as the load of the engine decreases, the supply of the fuel is cut down in proportion to the total charge. Close regulation can be obtained by this method, with proper weight of fly-wheel.

c. This method is accomplished by:

(1) Part of the charge being forced back into the suction passage, in which case the inlet valve is controlled by the governor.

(2) The entire charge being cut off at the proper time and expanding behind the piston for the rest of the stroke. Cut-off method.

(3) The charge is throttled down throughout the entire suction stroke. Throttling method.

The principal objection to the quantity method of governing is that the compression pressure is decreased and consequently the cylinder efficiency is reduced.

This method gives close regulation, however, and down to ½ load is equal to the hit-and-miss method.

d. This method is a combination of the quality and quantity methods of governing, but no better results have so far been obtained.

e. In varying the time of ignition both governor and hand control have been tried, the former with poor results, but the latter with better results.

The time of ignition, however, should be adjusted to suit the charge. For a decrease of load, the spark should be advanced.

2. For the methods described under a, b, c, and d, the centrifugal governor is generally used.

The pendulum type of governors are extensively used under a.

3. High-speed and large, stationary engines are provided with some means of relieving the exhaust for starting. One method requires an extra set of cams on the exhaust cam shaft.

10. ADVANTAGES AND DISADVANTAGES OF HIGH- AS COMPARED WITH LOW-SPEED ENGINES

High Speed

1. Advantages

a. For the same H.P., lighter in construction and more compact.

b. Less heat lost by radiation, etc., consequently more useful work obtained from same quantity of fuel.

c. Cheaper first cost.

2. Disadvantages:

a. Quick destruction of bearings and racking of engine in general.

b. Too great a speed will increase the inertia and other forces beyond safe limits, besides causing undue wear.

c. Ignition must occur early, or else the piston will have completed the compression stroke and started out before the charge is entirely burned.

d. Unreliability for long and continued use due to lightness of parts and great racking effect of high speeds.

e. Greater cost of upkeep and attendance.

Low Speed.

1. Advantages:

a. Best results are obtained by running an engine at the slowest speed possible for the development of the power required.

b. Less destruction of bearings and greater reliability for long and continuous use.

c. Better ignition, reverse of disadvantage given under c of high speed engines.

d. Less cost of upkeep and attendance.

2. Disadvantages:

a. Greater weight and space required for same H.P.

b. Greater loss of heat due to radiation, etc.

c. Greater first cost.

The piston speed is limited by the mechanical construction and the strength of the materials used. Too great a speed will greatly increase the inertia, etc.

The following are the average piston speeds found in use:—

Small stationary	engines	600	feet	per	minute.
Medium "	"	800	"	"	"
Large "	"	900	"	"	"
High speed	"	1200	"	"	"
Automobile	"	1200	"	"	"
Marine	"	1200	"	"	"

Note:—The piston speed refers to the total travel back and forth.

11. RATIO OF WEIGHT TO RATING

No fixed rule can be given as to the weight of gasolene engines per H.P. rating.

The design, purpose for which used and by which firm manufactured, determine to a great extent the ratio of weight to rating.

"Gasolene engines weighing about 2½ pounds per H.P. have been constructed for flying machines and racing purposes, while many stationary engines average 500 lbs., per H.P., or more for slow speeds." (Page 20, Gas Engine Theory and Design, by Mahrtens.)

High speed automobile engines average 10 lbs. per H.P.

Fig. 10 gives some idea of the weight per H.P. of engines of various design as now manufactured, as well as their weight ratio to speed.

12. THE FOLLOWING FEATURES ARE RECOMMENDED FOR SERVICE ENGINES OF STATIONARY TYPE

1. Four cycle, on account of greater efficiency and the fact that the weight permissible allows the installation of sufficient cylinders to overcome the disadvantages of power distribution.

2. Four cylinders or more, not exceeding six, give good power distribution and speed regulation, and a greater number become too complicated for the experience of the attendants usually available.

3. Make-and-break ignition, or the jump-spark, with Eisemann low-tension magneto, are recommended. The first is much the simpler and is efficient for the speeds recommended. The second method is the next choice, on account of the electrical advantages of the low-tension generator over the high-tension systems; for higher speeds than those recommended this method is preferable. Either system to be operated on a half-time shaft.

4. Inclosed cooling system with fan. This is advantageous where good water is scarce, which is the case at many coast artillery posts.

5. Lubrication should be of the pressure system, with telltale gauges at each end of the system, and test cocks in each branch as near the lubricated parts as possible. The advantages of this system being less required attention during operation.

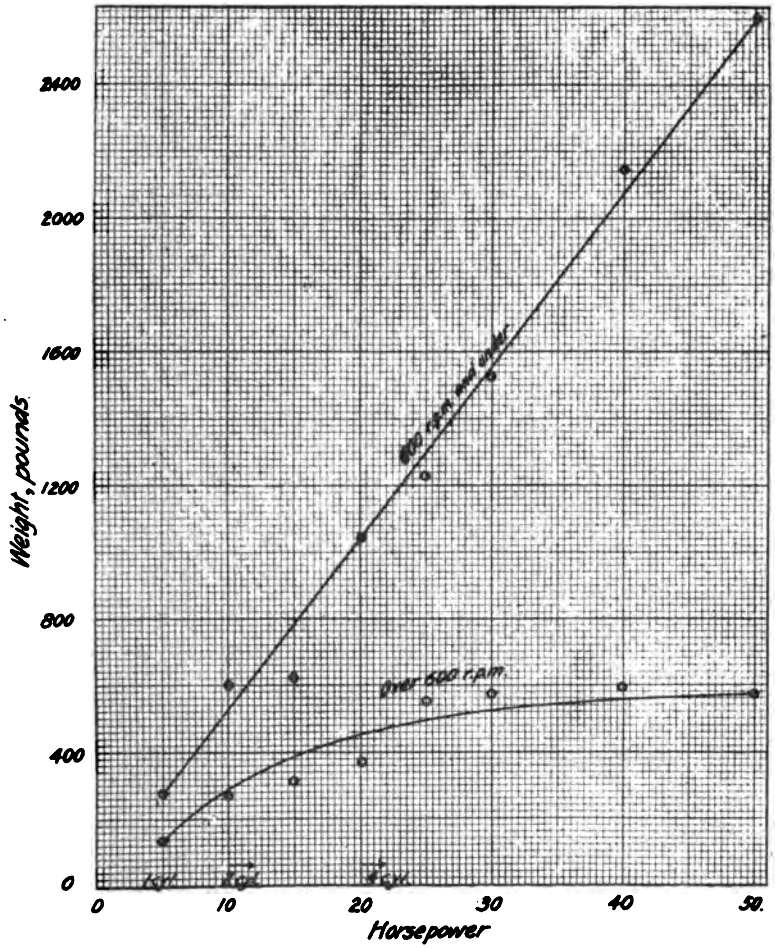


FIG. 10. GASOLENE ENGINES

Relation between weight and rating average obtained from 41 catalogs

6. No special starting device is needed if the sizes are limited to the present requirements of 15 and 25 k.w. sets for reserve plants and searchlights.

7. The speed of engine should regulate within 2% to 4%, by a throttle operated by a centrifugal governor. This method gives the closest speed regulation obtainable.

8. Speed about 400 to 600 r.p.m., for the reasons set forth in section 10 of the problem.

9. Inlet and exhaust valves should be operated by cams on half-time shaft.

10. All parts of engines should be interchangeable, to facilitate supply of parts.

13. OPERATION OF THE FOLLOWING ENGINES

1. *25 k.w. General Electric gas-motor set.*—This set was first examined and operated with a view of putting same in best adjustment for heat efficiency test. The results obtained from full and 25% overload runs are given in detail under part 14 of this problem.

Aside from the speed regulation obtained during the full load run, the operation of the engine was very satisfactory. The irregular speeds obtained on the full load were undoubtedly due to miss-firing in cylinder No. 3, as after the run the intake valve was found to be stuck and upon being taken out, the rod was found to be slightly bent.

Some difficulty was had with the gasolene feed pump, when running on reserve supply tank. Apparently the level of gasolene was below the lift level of the pump, or a leak had developed somewhere in the supply pipe.

2. *6½ k.w. General Electric gas-motor set.*—This set is similar to the 25 k.w. General Electric set except, (1) there is only one cylinder and, (2) the "ignition system", which is of the jump-spark type, the current being supplied by a low-tension "Bosch" magneto operated by a cam on the half-time shaft and a spring; the former moves the armature in such a way that it cocks the spring, and when the cam releases, the spring moves the armature very rapidly in the field. The spark is thus independent of engine speed and the engine is started on the magneto, cranking being done by hand.

The Bosch magnetic spark plug is used on this engine. The spark is made by moving the hammer bar away from the anvil (see Fig. 11), against the action of the spring, (which is not shown in the figure), thus breaking the electric circuit which has been made by the magneto, as described above.

3. *Standard engine.*—This is a 4-cycle, 2-cylinder engine, make-and-break ignition, wet batteries, or magneto. Mechanical

oiler and grease cups. Open cooling system, operated by a reciprocating pump, the jacket water having its outlet in exhaust pipe, cooling same. Float carburetor, speed 300 r.p.m. (350 actual), timer and throttle.

Special features are, (1) centrifugal throttling governor for limiting the speed when clutch is thrown on neutral; (2) auxiliary automatic air-valve to admit cold air to cylinder, in addition to the mixture fed from the carburetor; (3) all half-time and slower periodic events operated by one half-time shaft.

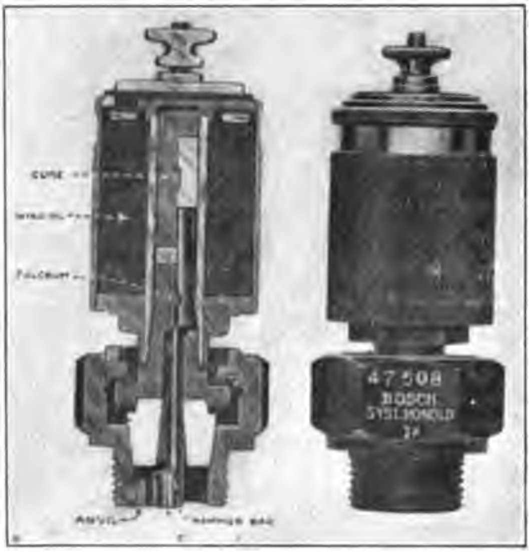


FIG. 11.

This particular engine pounds at all speeds indicating poor alignment of shaft and wear of bearings. The installation of the timing device on the standard engine is mechanically defective in that upon being advanced to a certain point it cannot be retarded again without removing the crank case cover.

Advance and retard directions should be indicated at the lever.

4. *Speedway engine.*—This engine is 4-cycle, 4-cylinder, with a make-and-break ignition, wet batteries only in use, 500 r.p.m., gravity oil sight feed from central tank and grease cups; float carburetor; open cooling system with rotary gear pump, cooling water has outlet in exhaust pipe, cooling same. It is also provided with the usual throttle and timer.

An auxiliary cock has been put between the carburetor and cylinder to admit cold air. (Engineer states that this was done because the carburetor is too large for the engine.)

This engine runs very smoothly when the throttle and timer are in exact adjustment, a slight variation of either causes pounding. The general effect of the engine is that of a high-speed type, though the r.p.m. are only 500.

5. *Cushman engine.*—This engine is a 2-cycle, 2-cylinder type with speed 950 r.p.m.; oil cups sight feed; open cooling system from large tank, jacket water has outlet in exhaust pipe for cooling same, reciprocating pump is used; float carburetor; jump spark; dry batteries; timer, and throttle. The engine is started by attached crank held in recess of fly-wheel by a spring. It is very hard to start, cranking must be continued and timer advanced, and relief cocks closed quickly on starting. Effect that of extremely high speed, with great vibration and racking.

REFERENCES

Internal Combustion Engines	Carpenter & Diederichs.
Elements of Electrical Engineering	Franklin & Esty.
Artillery Circular "D"	
Gas, Gasolene & Oil Engines	Hiscox.
Lecture on Gasolene Engine Design	Mr. Henri G. Chatain, E. E.
Modern Gas Engine & The Gas Producer	Levin.
Manual of Oil Motors & Their Uses	G. Lieckfeld.
Carburetors, Vaporizers & Distributing Valves	Butler.
Automobile Troubles & How to Remedy Them	Chas. P. Root.
American Cyclopedia of the Automobile	
Modern Gas Engine & Producer Gas Plants	Mathot.
Motor Car Principles.	Whitman.
The Gas & Oil Engine.	D. Clerk.
Gas Engine Design.	Lucke.
Gas Engines for Fortification Work.	Capt. E. Landon, C. A. C., Artillery Journal, March-April, 1908.
Friction & Its Reduction.	Wheeler.
Friction & Lost Work in Machinery.	Thurston.

(To be continued. Tests and conclusions to follow in next number.)

observers on scale "A". The range of the splash will then be found opposite the apex angle.

The operations of subtraction do not delay the solution of the problem.

Should the field of fire not be visible from the battery, an observer at the nearer base end station is substituted for the battery observer.

The base line length then is used on the range rod and the range deviation found *is* the deviation referred to the nearer base end station. For purposes of finding the relation which the range of splash bears to range of target, in order to make a range correction in the proper direction, this method is sufficiently accurate.

Figure 2 represents a board carrying two arms, A and B, centered at stations a and b, occupied by observers equipped with telescopic sights. Arm B is provided with an auxiliary arm centered at Station a. The auxiliary arm and arm A carry at their outer extremities index boxes provided with thumb nuts and worm gears which permit a movement of 2° in either direction. The azimuth circle is graduated so as to read correct azimuths from station a.

The operation of the board is as follows: Station a will be at the battery if the field of fire is visible therefrom, otherwise it will be at the nearer base end station. After the data pertaining to the set-forward point has been determined, the plotter announces its range and azimuth from the battery. A point is then located on the board by setting this data on arm A. Arm B is then set so as to intersect arm A at this point, both arms are clamped and zero of scale S is set at the located point. Observers in telephonic communication with the plotting room report the deflection errors of the splash (from stations a and b). Arms A and B are moved by the thumb nuts referred to above in accordance with the readings reported. The range deviation is then indicated on the moveable scale S.

Fig. 3 represents a chart of correction curves constructed so as to indicate range deviations corresponding to various deflection errors read on the splash at base end stations. These deviations are measured on the plotting board assuming, first, deflection errors from one station and line shots from the other; and, second, deflection errors from the latter station and line shots from the former. Deviations for ranges 1,000 yards apart are determined in this manner and one set of such deviations is made for every 15° or 20° in azimuth throughout the field of fire.

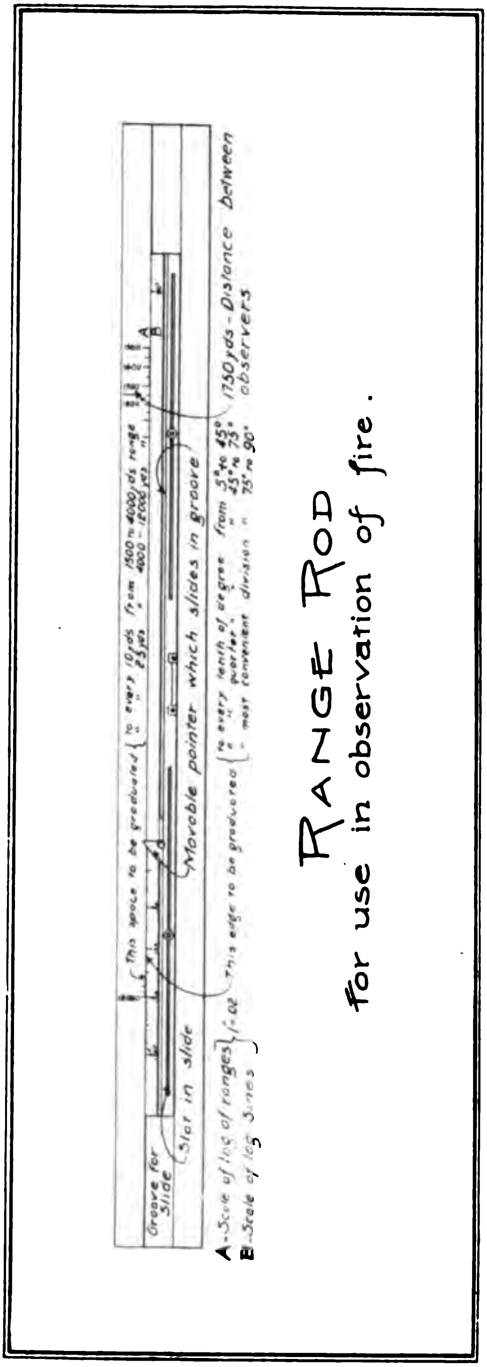

RANGE ROD
for use in observation of fire.
Groove for Slide
Slot in slide
This space to be graduated { to every 10 yds from 1500 to 4000 yds range
" " 25 yds " 4000-12000 yds "
Movable pointer which slides in groove
This edge to be graduated { to every tenth of degree from 5° to 45°
" " quarter " " 45° to 75°
" most convenient division " 75° to 90°
1750 yds - Distance between observers
A
B
A - Scale of log of ranges } f = .02
B - Scale of log Sines

FIG. 1.

observers on scale "A". The range of the splash will then be found opposite the apex angle.

The operations of subtraction do not delay the solution of the problem.

Should the field of fire not be visible from the battery, an observer at the nearer base end station is substituted for the battery observer.

The base line length then is used on the range rod and the range deviation found *is* the deviation referred to the nearer base end station. For purposes of finding the relation which the range of splash bears to range of target, in order to make a range correction in the proper direction, this method is sufficiently accurate.

Figure 2 represents a board carrying two arms, A and B, centered at stations a and b, occupied by observers equipped with telescopic sights. Arm B is provided with an auxiliary arm centered at Station a. The auxiliary arm and arm A carry at their outer extremities index boxes provided with thumb nuts and worm gears which permit a movement of 2° in either direction. The azimuth circle is graduated so as to read correct azimuths from station a.

The operation of the board is as follows: Station a will be at the battery if the field of fire is visible therefrom, otherwise it will be at the nearer base end station. After the data pertaining to the set-forward point has been determined, the plotter announces its range and azimuth from the battery. A point is then located on the board by setting this data on arm A. Arm B is then set so as to intersect arm A at this point, both arms are clamped and zero of scale S is set at the located point. Observers in telephonic communication with the plotting room report the deflection errors of the splash (from stations a and b). Arms A and B are moved by the thumb nuts referred to above in accordance with the readings reported. The range deviation is then indicated on the moveable scale S.

Fig. 3 represents a chart of correction curves constructed so as to indicate range deviations corresponding to various deflection errors read on the splash at base end stations. These deviations are measured on the plotting board assuming, first, deflection errors from one station and line shots from the other; and, second, deflection errors from the latter station and line shots from the former. Deviations for ranges 1,000 yards apart are determined in this manner and one set of such deviations is made for every 15° or 20° in azimuth throughout the field of fire.

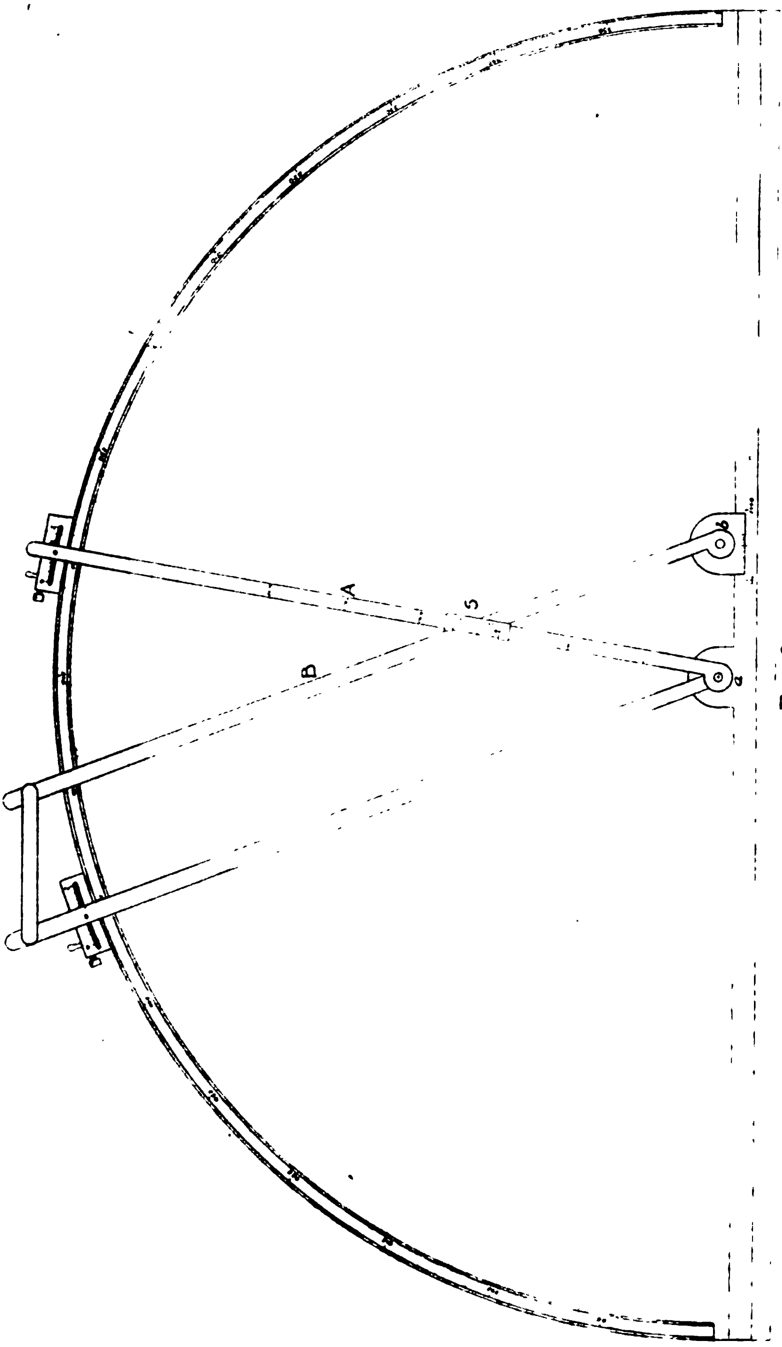


FIG. 2.

The resulting sets of data are represented graphically as in Fig. 3. These sets may be mounted separately on cardboard, or shown successively on one sheet, means being provided to shift the sets by rollers at either end.

The operation of the chart is as follows: Observers at base end stations are in telephonic communication with the plotting room. The set of curves approximately corresponding to the azimuth of the set-forward point is selected. The vertical slide V is set at the approximate range of the set-forward point. The zero of the horizontal slide H is set at the reading received from the B′ station, and the range deviation will be indicated at the curve pertaining to the deflection error from B″ station. Pointer P may be omitted.

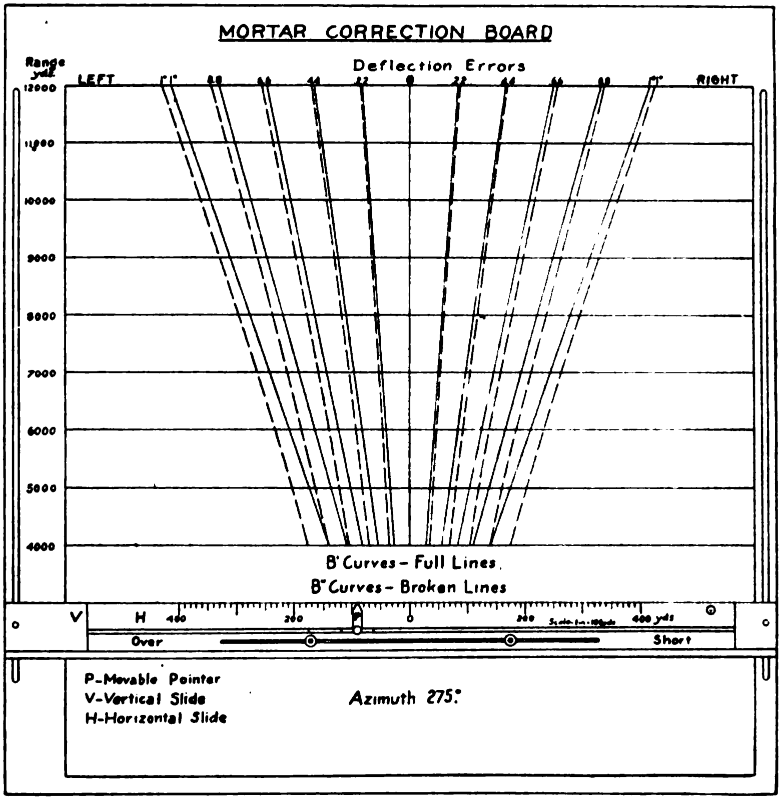


FIG. 3.

Fig. 3 pertains to a battery which is located between its base end stations, the primary being on the right looking towards the field of fire.

A fourth method of finding the approximate range deviation may be used without preparing apparatus or charts as indicated above.

The method is applicable over a field of fire of about 25° to either side of a normal to the base-line at the battery.

The method assumes that a right or left deflection error of any given amount from one station corresponds to the same range deviation as does the same deflection error of the opposite sign from the other station.

Ascertain by measurement on the plotting board the range deviation for each 1,000 yard range from the battery corresponding to a .10 degree deflection error observed at one station, a line shot being assumed from the other station.

Range deviations are then tabulated on the following form as deflection errors are reported:

Def. error B'' sta.	Def. error B'' sta. with sign changed.	Def. error B' sta.	Total def. error referred to B'.	Range of target from battery announced by plotter.	Range deviation corresponding to .10° def. error from B'.	Observed range deviation.
°	°	°				
.25 L	.25 R	.25 R	.50 R	5000	10 yds.	50+
.25 R	.25 L	.25 R	0	5000	10 "	0
.25 R	.25 L	.50 R	.25 R	7500	15 "	42+
.25 R	.25 L	.25 L	.50 L	10000	20 "	100—

[The above suggestions by "Observer" seem to be pertinent, in view of the provisions of the Coast Artillery Memorandum referred to. The object of the writer is to provoke discussion upon this subject. It is hoped that this object will be attained. Any comments will be welcomed both by the writer and by the JOURNAL. -*Editor.*]

PROFESSIONAL NOTES

THE STIFFNESS OF GUNS

By Lieutenant H. J. Jones, Army Ordnance Department, Inspector of Ordnance Machinery

The Comparative Stiffness of Modern Built-Up, Solid and Wire-Wound Guns, and the Initial Unsteadiness of Projectiles

The fact that England and America are the only countries in which wire-wound guns can be said to have a vogue, has long been to many so significant as to merit more than the occasional comment which the fact provokes. Such a marked contrast in the practice of the English-speaking and foreign gun-makers is not accompanied, apparently, by a corresponding contrast in the ballistic effect, measured by the muzzle energy obtained per unit weight of gun, or by safety, or by money cost. On comparing the published tables of the great gun-makers, there appears to be a general equality of performance of guns, whether built-up, solid, or wire-wound; and the obvious disinclination of foreign arsenals to consider the estimated increase in circumferential strength as worth the time and trouble taken to produce it; together with the importance of the mere stiffness, or girder, strength of guns, apart from bursting strength, now that guns are increasing in length, in responce to the call for higher muzzle velocity, leads materially to the consideration of the comparative stiffness of the two types for guns of equal strength, or rather for guns designed to give the same performance—a certain muzzle velocity with a certain maximum pressure.

The theory of the investigation is outlined in the appendices subjoined, a modern 12-inch 50-caliber gun being taken as the subject. The design of both guns—solid and wire-wound—is suitable for a muzzle velocity of 3000 feet per second, with a maximum pressure of 20 tons, and a muzzle pressure of 7 tons per square inch. The wire-wound gun, wired throughout its length, is of the usual construction; having a rifled inner A tube; an A tube; and layers of wire varying from 16 at the muzzle to 80 over the chamber, the wire being covered by a jacket and B tube.

The portion of the gun forward of the cradle is considered as a cantilever, and in the appendices there are investigated the droop of the muzzle relative to the axis of the cradle; the effect of sunshine in modifying this droop; together with the nature of the transverse vibrations of the muzzle on firing. The general results may be stated thus:—

12-Inch Breech-Loader 50-Caliber Guns

Muzzle velocity	3000 feet per second
Maximum pressure	20 tons
Length of gun forward of cradle	36 feet

	Wire-Wound.	Built-Up Solid.
Droop of muzzle	4.45 min.	2.35 min.
	0.172 in.	.092 in.
Time of vibration (fundamental)	0.007633 sec.	0.006870 sec.
Number of vibrations per second	131.1	145.5
Maximum upward velocity at muzzle	12 ft. per sec.	7 ft. per sec.

Taking the above as representative figures for modern well-designed 12-inch 50-caliber guns, we note that the droop due to mere weight is about 4½ minutes of arc for the wire-wound, and 2½ minutes for the solid gun.

Now since mere temperature strain can also cause a bend, in any direction, of from 2 to 3 minutes of arc, it follows that a wire-wound gun may have a total droop of about 7 minutes when the uppermost portion of the gun is the hottest region; or of 2 minutes when the lowermost portion is the hottest. With badly-designed guns, the droop due to lack of girder stiffness may reach four or five times the above values. In the case of built-up solid guns the maximum droop due to weight and temperature strain will be about 5 minutes of arc, and the minimum less than a minute.

With the well-designed guns investigated, the maximum velocity from the upward "whip" of the muzzle is about 12 feet per second with the wire-wound, and 7 feet per second with the solid gun. But with a bad example of wire-wound gun the "whip" velocity may reach from 50 feet to 60 feet per second.

Apart from the inconvenience of this variable droop, since sights cannot be accurately set or tested against the last few feet of rifling, and it is difficult to set or test them against the axis of the bore at the breech, it is important to consider the effect of the "whip" on the accuracy or consistency of shooting. It is obvious that, since the period of oscillation of the muzzle has no connection with the travel of the projectile along the bore, we may have the muzzle moving up, or down, or being practically at rest just at the instant when the projectile leaves the bore, and is receiving acceleration due to the impulse of the muzzle-blast. The weight of the charge for a modern high-velocity 12-inch gun will be about one-third the weight of the projectile, and with the usual muzzle pressure of about 7 tons per square inch, the maximum velocity of the muzzle-blast will be from 5500 feet to 6000 feet per second. In other words, the blast will meet the base of the projectile with a relative velocity of about 2500 feet per second, the effect of which is to give the projectile a probable increase of 50 feet to 80 feet per second in velocity after the projectile has left the rifling.

With a gun that is very weak to resist bending stresses, we may get the projectile, at the muzzle, receiving, whilst in the gun, upward or downward velocity of 50 feet to 60 feet pre second, in addition to the translational velocity; and, in addition, the general direction of the muzzle-blast may be inclined at from 10 to 15 minutes to the axis of the projectile. The result is that the projectile immediately on leaving the gun has a more or less systematic wobbly motion, which continues up to 500 yards, and probably to a considerably greater distance.

This initial unsteadiness has been studied by erecting cardboard screens between the gun and a plate, the gun being laid by cross-wires at the muzzle and breech on to a cross on the distant plate, the screens being then interposed at convenient distances.

It has been found that the holes in the screen are by no means circular, and that the centers of the holes lie on a fairly regular spiral path about the mean trajectory, the pitch of the spiral being from ten to twenty times the pitch of the rifling at the muzzle. The holes are roughly elliptical in shape, the major axis being from $1\frac{1}{4}$ to $1\frac{3}{4}$ the diameter of the projectile, and the minor axis about equal to the diameter of the projectile. This ellipticity corresponds to the axis of the projectile lying across the trajectory at an angle approaching 12 degrees. If the inclination of the major axis to a vertical line be noted, it is found that as we proceed from the screen nearest the gun and go towards the plate, the major axis has a rotational motion, which may be clockwise or anti-clockwise, a gun giving indifferently one result or the other, from round to round. Records of the actual flight of a projectile can only be taken in this way for short distances, owing to the curvature of the trajectory; but, as far as available information goes, it would appear that a projectile, on leaving a long gun, is whipped up or down, or to the left or right; assumes an inclined position, in plan, across the trajectory; and describes a fairly regular spiral path about a trajectory, which may be a few inches, or a foot or so, displaced from the direction of the muzzle of the gun before firing.

It is not possible at present to say what proportion of this initial unsteadiness is due to eccentric engraving of the driving band, or to the center of gravity of the projectile being out of the axis of figure. But the whole question merits attention, since a badly-designed wire gun may give at short ranges—armor-proof firing—such irregular results that the particular object of the firing—namely, the proof of plates or projectiles—may be entirely obviated.

APPENDIX I.

Application of the Theory of Bending to Long Guns

In Fig. 1 A B is the datum of reference for deflection y and slope θ. The angular deflection at any point is then the angle between the direction of the beam at that point and A B.

Linear scale 1 inch = λ inches.

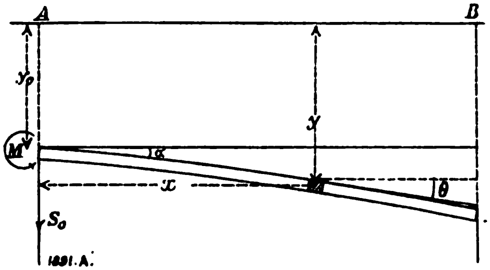


FIG. 1.

Fig. 2 represents the diagram of load intensity. The diagram is divided into a number of strips, the load being assumed as acting at the center of gravity of each strip. The 12-inch 50-caliber gun discussed is divided into 50 strips of equal width, the portion of the gun in front of the cradle being considered as a cantilever, and deflection considered relative to the axis of the cradle. If D be the external diameter of the gun at any point, then the ordinate of the load-intensity diagram at that point will be proportional to (D^2 — 144), since the internal diameter is constant—namely, 12 inches.

Considering the equilibrium of an elementary strip, we have, as indicated in Fig. 2, shearing forces S and S + dS at the ends, and the weight wdx at the center of gravity. And these forces form, with the bending moments M, and M + dM, a system in equilibrium. Hence, resolving vertically, we have

$$d\,S = w\,d\,x,$$

or

$$S = S_0 + \int_0^x w\,d\,x.$$

Let the load-intensity scale be 1 inch = w pounds per square inch.

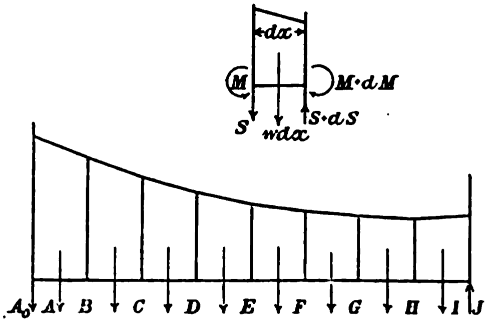


Fig. 2.

Fig. 3 represents the diagram of shearing force. It is obtained by setting down to the load scale on A$_0$J the respective areas of the parallel strips of the load diagram. If the strips are of equal width, this can be done by taking a certain fraction of each mid-ordinate to represent the area of the diagram. The point A$_0$ . . . J are projected across to corresponding lines set down from the mid-points of the strips, and a fair curve drawn through the points so obtained.

Let the shearing-force scale be 1 inch = a square inches of load-diagram, or

$$1 \text{ in.} = \lambda\,w\,a = s \text{ lb.},$$

where

$$s = \lambda\,w\,a.$$

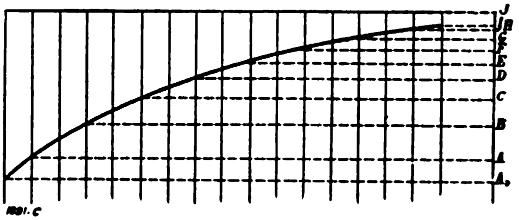


Fig. 3.

Fig. 4 is the diagram of bending moment. It is obtained by taking any pole O, polar distance from the line of loads being h; and in the respective spaces drawing lines parallel to O A, O B . . . O J, &c. Considering the equilibrium of the elementary section shown in Fig. 2, and taking moments about the center of gravity, we have

$$(\mathrm{M} + d\,\mathrm{M}) - \mathrm{M} = (\mathrm{S} + d\,\mathrm{S})\frac{d\,x}{2} + \frac{\mathrm{S}\,d\,x}{2},$$

or

$$d\,\mathrm{M} = \mathrm{S}\,d\,x + \frac{d\,\mathrm{S}\,d\,x}{2}.$$

Neglecting infinitesimal quantities of the second order, we have, on integrating

$$\mathrm{M} = \mathrm{M}_0 + \int_0^x \mathrm{S}\,d\,x,$$

which is of the same form as the relation obtained for shearing force. Hence the important results.

1. The increase in any ordinate of the shearing-force diagram is equal to the area between its two positions on the load-intensity diagram.
2. The increase in any ordinate of the bending-moment diagram is equal to the area between its two positions on the shearing-force diagram.

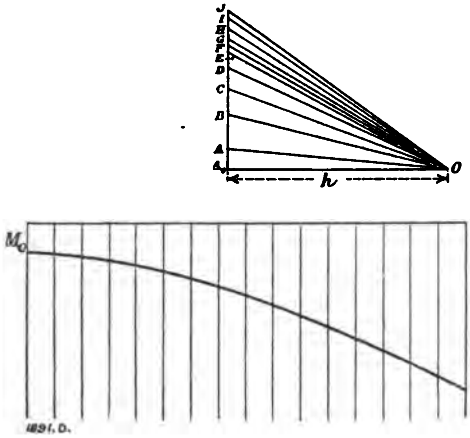


FIG. 4.

To obtain the bending-moment scale we have: Length of ordinate on the linear scale × polar distance on the load scale = bending-moment scale.

Hence bending-moment scale is 1 inch = $\lambda s h$ pound-inches, h being the polar distance, or 1 inch to μ pound-inches, where $\mu = \lambda s h = \lambda^2 \omega a h$.

In Fig. 5 consider an elementary length of the beam ds. Suppose dy to be the increase in deflection, and $d\theta$ to be the increase in slope. Then $d\theta = \frac{d\,s}{\mathrm{R}} = \frac{d\,x}{\mathrm{R}}$, if the deflection is small, and R is the radius of curvature at the point considered. Now from the ordinary elastic theory of long beams we know that $\frac{\mathrm{M}}{\mathrm{I}} = \frac{\mathrm{E}}{\mathrm{R}}$, where M is the bending moment at any section, I the moment of inertia of the section, E Young's modulus, and R the radius of curvature.

Hence

$$d\,\theta = \frac{d\,x}{\mathrm{R}} = \frac{\mathrm{M}\,d\,x}{\mathrm{E\,I}} = m\,d\,x, \text{ where } m = \frac{\mathrm{M}}{\mathrm{E\,I}}.$$

Integrating we have

$$\theta = \theta_0 - \int_0^x m\, d\, x,$$

which is identical with the relation found for shearing force, so that the slope θ corresponds to the shearing force s.

Also

$$d\, y = \theta . d\, x,$$

and integrating we have

$$y = y_0 + \int_0^x \theta\, d\, x,$$

$$= y_0 + \theta_0\, x + \int_0^x \int_0^x \theta\, d\, x\, d\, x,$$

which is identical in form with the relation found from bending-moment equation—namely,

$$\mathrm{M} = \mathrm{M}_0 + \mathrm{S}_0\, x + \int_0^x \int_0^x w\, d\, x\, d\, x.$$

Hence the deflection y corresponds to the bending-moment M.

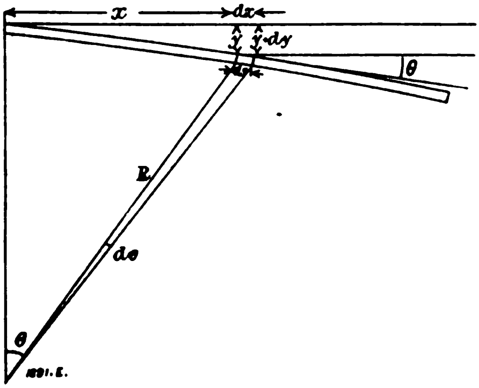


FIG. 5.

Now $m = \dfrac{\mathrm{M}}{\mathrm{E\,I}}$, and if E I be constant for the various sections of the beam, the ordinate of the bending-moment diagram will be proportional to the slope intensity m. If, however, I varies from point to point, as it does in a gun, then each ordinate of the bending-moment diagram must be divided by its corresponding I to make it suit the slope-intensity diagram. Hence, generally, the bending-moment diagram may be used to a certain scale, as the diagram of slope intensity m $\left(\dfrac{\mathrm{M}}{\mathrm{E\,I}}\right)$ radians.

Now, as before, we have:—

1. The increase of any ordinate of the slope diagram is equal to the area between its two positions on the slope-intensity diagram.

2. The increase in any ordinate of the deflection diagram is equal to the area between its two positions on the slope diagram.

Hence, comparing the same ordinate on each of the diagrams, we have:—
Bending moment: shearing force: load intensity = deflection: slope: slope intensity.

Hence, by the same method as before, we can convert the bending-moment diagram into the slope-intensity diagram, then into the slope diagram, and finally into the deflection diagram; the last diagram being, of course, to a certain scale, the actual shape of the bent beam.

The above method is of universal application, since, if we know the distribution of the load, and the section of the beam, everywhere, we can proceed by mere adding of mid-ordinates of the strips to the deflection diagram.

The following important corollaries may be noted:—

1. The area of the $\frac{M}{EI}$ curve between any two places is the increase in slope between those places. Consequently the whole area of the $\frac{M}{EI}$ curve, from the cradle to the muzzle, in the gun problem, equals the total bend; in other words, the droop of the muzzle compared with the cradle.

2. Tangents to the curve, showing the shape of the bent beam at any two points, meet in a point vertically above the center of gravity of the area in question.

3. When comparing the total droop of solid and wire-wound guns, providing the same scales are used throughout, the mere ratio of the areas of the $\frac{M}{EI}$ curves, between the cradle and muzzle, gives the ratio of droop-angles direct.

In actual practice it is preferable to use a modification of the graphical method outlined above, and in the investigation of the 12-inch gun the following method was adopted:

The portion of the gun forward of the cradle—36 feet in length—was divided into fifty discs, of equal width, each disc being thus 8.64 inches wide. From the center of gravity of each disc was set down an ordinate proportional to $(D^2 - 144)$, D being the mean external diameter of a disc, and 12 inches, the internal diameter of the hole. The weight of any disc in pounds was thus $\frac{\pi}{4}(D^2 - 144) \times 8.64 \times 0.28$, taking steel at 0.28 lb. per cubic inch. In this way we obtain the diagram of loads (Fig. 6) as indicated. Each ordinate on this diagram must be multiplied by 190.08, to give the load in pounds per unit length, at the particular place.

The diagram of loads is then integrated to give the diagram of shearing force, and the diagram of shearing force to give the diagram of bending moment. The moment of inertia of each mid-cross section of the 50 discs is now calculated, and the bending moment at each place divided by its corresponding moment of inertia. This gives the diagram of slope intensity, from which, by double integration, we obtain the diagram of slope and the diagram of deflection.

The process of integration is best performed arithmetically, as shown in the accompanying abstract.*

Since the deflection at 50, the cradle, is zero, we have to subtract the value of the deflection corresponding to 50 in the deflection diagram from each ordinate, in order to get the deflections in the form of gun horizontal at cradle. The deflection at the muzzle is thus represented by

$$-206.724 \times \frac{1642.3 \times 8.64 \times 8.64}{147 \times 10^6} = 0.172 \text{ in.}$$

The slope in radians is obtained in a similar way from the slope column.

---

* See page 71.

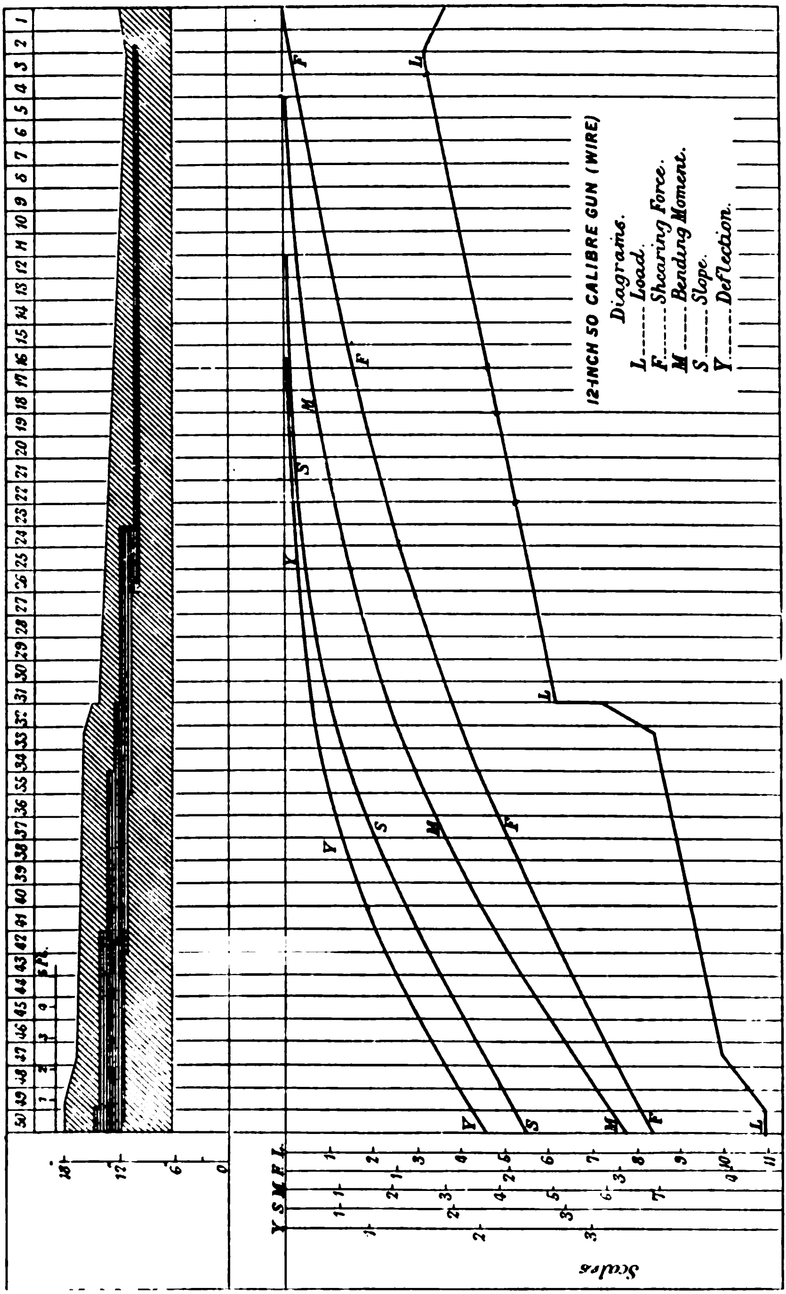

12-INCH 50 CALIBRE GUN (WIRE)
Diagrams.
L------Load.
F------Shearing Force.
M------Bending Moment.
S------Slope.
Y------Deflection.
L
F
M
S
Y
5 Ft.
Scales
Y S M F L

FIG. 6.

ABSTRACT.—12-INCH 50-CALIBRE (WIRE) GUN.

Ordinate.	Load L.	Shearing Force F.	Bending Moment M.	Moment of Inertia I.	Slope Intensity $\frac{M}{EI}$	Slope S.	Deflection Y.	Deflection Y'.
1	3.60	3.60	1.80	19	0.096	0.048	0.024	−206.27
2	3.25	6.85	7.04	15	0.470	0.331	0.214	−206.27
3	3.28	10.13	15.53	16	0.970	1.050	0.90	−206.26
4	3.40	13.53	27.36	17	1.61	2.34	2.60	−206.25
5	3.48	17.01	42.63	18	2.37	4.33	5.94	−206.21
10	4.00	35.95	173.97	23	7.54	28.07	76.67	−205.51
15	4.56	57.61	406.73	28	14.52	82.65	339.53	−202.88
20	5.08	81.92	754.47	35	21.55	172.81	964.82	−196.63
25	5.60	108.89	1230.45	43	28.60	298.95	2129.7	−184.97
30	6.83	139.17	1848.15	60	30.80	457.65	4011.3	−166.16
35	9.05	183.37	2652.91	84	31.56	594.53	6631.8	−139.96
40	9.30	229.37	3684.3	81	45.48	785.15	10053.4	−105.74
45	9.58	276.65	4948.8	82	60.30	1056.32	14623.8	− 60.04
50	10.95	330.28	6464.1	111.6	57.92	1340.14	20627.4	0
f	190.08	190.08	1642.3	$\frac{\pi}{64} \times 10^4$	$\frac{1642.3}{147 \times 10^8}$	$\left(\frac{1642.3}{147 \times 10^8} + 8.64\right)$	$\left(\frac{1642.3 \times (8.64)^2}{147 \times 10^6}\right)$	$\frac{1642.3 \times (8.64)^2}{147 \times 10^6}$

The factor *f* in each column indicates that each ordinate in diagrams must be multiplied by 190.08 to give force in pounds; by 1642.3 to give the bending moment in pound-inches; by $\frac{1642.3}{147 \times 10^8} \times 8.64$ to give the slope in radians; and by $\frac{1642.3 \times 8.64 \times 8.64}{147 \times 10^6}$ to give the deflection in inches.

To determine the time of the fundamental oscillation, we take the respective values of w and y from the load and deflection columns, and calculate the time in accordance with the relation

$$T = 2\pi\sqrt{\frac{\Sigma\,(w\,y^2)}{g\,\Sigma\,(w\,y)}}$$

applying a correction for the value of k, being comparable with that of l, the length.

APPENDIX II.

THE EFFECT OF TEMPERATURE STRAIN ON THE STRAIGHTNESS OF LONG GUNS

The flexure of a long gun, due to the unsupported weight of metal in front of the cradle, is modified to a considerable extent by a mere general difference of temperature between one side of the gun and the other. This temperature difference, due to the effect of sunshine, &c., has been found to amount to about 2 degrees Cent. for ordinary temperate summer conditions, and to about 4 degrees Cent. in the tropics. Generally the uppermost surface of the gun is hotter than the lowermost, but cases have been met with where the reverse was the case, due probably to the different reflective and absorptive capacities of the colored paints used to render the gun inconspicuous against its surroundings. The effect of a cross-wind being to cool the windward side, it will be seen that a general temperature difference of from 2 degrees to 4 degrees Cent. may be met with under the conditions of the top, bottom, right, or left being the hottest region. It is certain that the general rise of temperature of the gun on firing is accompanied by a rise in this temperature difference, particularly if a cross-wind be blowing.

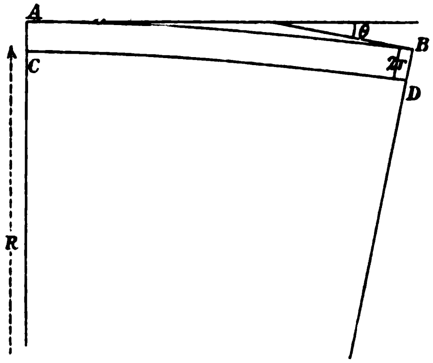


FIG. 7.

It may be shown by means of an optical lever drawn along the bore at various times of the day, or by noting the total droop by setting the gun clinometer plane against the last few feet of the rifling at the muzzle, that the total flexure of a 12-inch 50-caliber gun alters during the day by an amount of the order of two to three minutes of angle; the centre of the bore at the muzzle, in fact, describes an oval figure diurnally, the major dimensions being about 0.25 in.

The matter is obviously of importance, since sights are usually set by ref-

[illegible] to the [illegible] few feet of rifling at the muzzle, a motion which varies two or three minutes of arc during the day.

The [illegible] droop due to a specified general temperature difference may be readily calculated. Assuming the side A B to be 1 deg. Cent. above the opposite side C D (Fig. [illegible]), then the difference in length between A B and C D will be [illegible] being the mean length and [illegible] the coefficient of linear expansion of steel per degree Centigrade. This difference in length is accompanied by the gun droop. [illegible] in length, assuming a curved shape of mean radius R, and [illegible] be the mean diameter of the exterior of the muzzle, we have:

$$\frac{AB}{CD} = \frac{R - [illegible]}{R - [illegible]}$$

or

$$\frac{AB - CD}{AB - CD} = \frac{[illegible]}{R}$$

Now

$$AB - CD = [illegible]$$

and

$$AB - CD = \frac{[illegible]}{10^6}$$

$$\frac{[illegible]}{10^6} [illegible] = \frac{[illegible]}{R}$$

or

$$R = \frac{[illegible]\,10^6}{[illegible]}$$

The total droop $t = \frac{[illegible]}{R}$ and since [illegible] = [illegible] and [illegible] = [illegible], the unit being feet, we have t per degree Centigrade = [illegible] or

$$t = [illegible] \text{ minute.}$$

Hence for a [illegible]-in. [illegible]-calibre gun we get about half-a-minute droop per degree Centigrade difference of temperature.

APPENDIX [illegible]

THE VIBRATION OF LONG GUNS

Photographic and other evidence has shown that gun-barrels have definite modes of vibration on firing, and that for long wire-wound guns, which are comparatively weak from the point of view of stiffness in bending, the vibration has a most marked effect on the initial conditions of projection and on the consistency of consecutive rounds at the short ranges of the proving ground.

It has long been known that the shooting of a small arm could be greatly modified by varying the nature of the constraints, such as by clamping the rifle to a heavy mass of iron, and the same fact holds true with respect to heavy ordnance, the whip and jump of which depends on the design of the recoil arrangements and the general stiffness and stability of the carriage, for in most modern carriages the axis of the buffer resistance is parallel to, but displaced from, the axis of momentum of the recoiling gun and its attachments, so that there is always a couple acting tending to rotate the gun, carriage and pedestal about a transverse horizontal axis. The pedestal being immovable, the gun and cradle receive motion about the elevating-shaft, and the carriage tends to jump off its front bearing on the roller-path.

But, in addition to this general rotary movement in elevation, there is a general stiffening of the bore, resulting from the imposition of firing stresses and the forward thrust of the projectile on the rifling. A 12-inch 50-caliber gun will have maximum bending stresses of about $1\frac{1}{2}$ tons per square inch; but on firing, the gun will present the familiar case of a cylinder under internal pressure, acting as a beam without compressive stresses. This stiffening of the bore, and its manifestation as a transverse vibratory state, constitutes what is known as "whip," or the upward movement of the muzzle of the gun relative to the chase.

In certain designs of wire-wound guns, where steps on the outer jacket, or B tube, occur over steps on the inner tube, thus causing a sudden large variation of effective moment of inertia to resist bending, and a correspondingly large degree of slope intensity—as much as 10 minutes in 3 feet has been met with—the whip of the gun—that is to say, the transverse vibratory state—becomes compound. The portion forward of the weak section vibrates in its own period about the weak section, and the whole of the muzzle portion in front of the cradle vibrates about the cradle.

We thus see that the actual stress state of the metal of a gun, on firing, is by no means the steady state of the hydraulic cylinder. There is the main radial vibratory firing stresses, proceeding from the internal to the external surface, and accompanied by reflection at each tube where a discontinuity of initial stress exists. The velocity of transmission of this stress state will be that of sound in steel, about 16,000 feet per second. The forward thrust on the rifling results in a vibratory stress proceeding along the inner A tube, at about 16,000 feet per second, and a longitudinal shear between the A and the inner A tube. The rotation thrust imposes a torsional stress on the inner A tube, which travels at about 9500 feet per second, and is accompanied by circumferential shear. In addition the inner A tube is always at a considerably higher temperature than the overlying A tube, owing to the high resistance to conductivity of heat offered by the surfaces of contact and the burnt film of lubricant between the tubes.

The effect of the longitudinal and temperature thrust on the inner A tube is seen in the common forward movement of the rifled inner A tube, particularly with rapid firing. And the circumferential shear shows itself in the turning of half-liners, &c.

The period of the transverse vibration can be calculated in general terms by noting that the time of vibration will depend on the stiffness of the gun in bending—namely, the product of Young's modulus, and the moment of inertia, on the mass per unit length, and on the length. We may thus write

$$T \infty s^a w^b l^c,$$

and since the dimensions of s are $\frac{M L^3}{T^2}$, we have, by equating dimensions,

$$T \infty l \sqrt{\frac{w}{E I}}$$

w being the total load vibrating.

In the case of a gun, a beam fixed at one end, the moment of inertia of the cross-section varies throughout the length, and to find the time of vibration we have to proceed by the general strain-energy method, equating the potential of the elastic forces of flexure to the kinetic energy of the vibrating mass in the mean position. In other words, if y be the deflection at any point where the corresponding load is w, the time of vibration is given by the relation,

$$T = 2\pi\sqrt{\frac{\Sigma\,(w\,y^2)}{g\,\Sigma(w\,y)}}.$$

The value of w may be taken from the load diagram, and the value of y from the deflection diagram, and T_1 thus determined.

The above involves the assumption that the radius of gyration of cross-sections is small compared with the length of the vibrating cantilever. But if the loading is of appreciable size, the frequency is lower than when the loading is concentrated along the neutral axis. Lord Rayleigh has shown that for a uniform beam clamped at one end, and free at the other, the period of vibration obtained for the fundamental oscillation, on the assumption that the beam is long compared with the radius of gyration of the cross-section, must be multiplied by the factor $\left(1-2.324\frac{k^2}{l^2}\right)$, to give the period for an actual beam, of which k is the radius of gyration and l the length.

For small displacements the vibration is sensibly simple harmonic, in which case if y be the maximum deflection at the muzzle, and v the linear velocity in the mean position, we have

$$v\,T = 2\,\pi\,y,$$

or

$$v = \frac{2\,\pi\,y}{T}.$$

v works out at 12 feet per second for the wire-wound, and 7 feet per second for the solid gun. But cases of badly-designed wire-wound guns have been noted in which v approximated to 50 feet to 60 feet per second.

—*Engineering*, December 30, 1910.

✦ ✦ ✦

SUBMARINE CABLE-LAYING AND REPAIRING*

By Charles Bright, F. R. S. E.

I should like to preface my lecture with the remark that I feel conscious that I have before me a task which, at best, I shall carry out with difficulty, partly because, while I am in comparatively little doubt as to what it might be considered suitable for you to know, I cannot well tell how much you already know. In putting myself in your position as far as possible, I have thought it best to follow the subject up in a sequence such as would apply to your requirements. Thus I assume in the first place that war is imminent, or has actually been declared, and that our country is one of the belligerents. This being so, we will conclude that it serves your purpose to make certain alterations in the existing state of things with regard to cables—to, say, interrupt communication with one spot, or establish it with another. Such operations could, of course, be effected by a man-of-war, provided the necessary apparatus and the required length of cable were at disposal. It is, indeed, now fairly well known that Russia has had at any rate one of their warships so furnished to meet emergencies; but in former times this was, perhaps, easier than it is today. We have here a classic example in H.M.S. *Agamemnon*—which was fitted out for laying the first Atlantic cable. There was, too, the United States naval frigate *Niagara*, lent by the American Government for the same purpose.

---

* Abstract of two lectures delivered to the Royal Naval War College.

In the present day, however, a man-of-war has, I imagine, less room for any additional gear either on the main or upper deck or 'tween decks. In any case, it would not probably be very easy to keep such gear permanently installed; and, if stowed away in reserve, the operation of setting it up at short notice is one that would be only justified in a case of considerable emergency, such as is seldom likely to arise. It would, in fact, be preferable nowadays either to charter a British telegraph ship—and there are over 50 of these vessels in service at the moment—or to lay hands on a foreign vessel of the same character.

Assuming that a telegraph ship has been retained, or captured, by his His Majesty's Navy, we should then have the necessary cable machinery already properly installed, together with an electrical testing room and instruments in their proper position; we also start with our cable ready made and to hand. The various operations associated with the manufacture, electrical and mechanical testing, and subsequent shipment of a telegraph cable, are outside your scope. I should, however, mention that the manufacture of a cable is preceded by an exhaustive survey—or submarine sounding expedition—with a view to determining the actual route and types of cable adapted to that route. It may be assumed that any telegraph ship will have some cable aboard, though a repairing vessel does not, as a rule, carry more than about 250 miles, any more considerable length being drawn, as required, from stocks kept by the companies, or foreign governments, in iron tank sheds situated at their more important landing points. These stores of cable you would, of course, make it your business to capture, if desirable, in the case of foreign ownership.

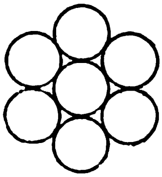


FIG. 1.

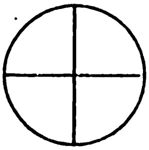


FIG. 2.

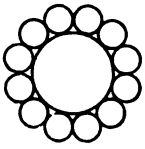


FIG. 3.

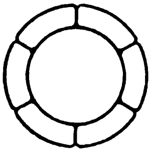


FIG. 4.

The lecturer proceeded to describe the interesting work of stowing cable in the tanks of a cable ship and at cable stores at stations. Proceeding, he said: This brings us to the subject of types of cables. As you are no doubt aware, the conducting wire is always composed of the purest possible copper, that having a higher electrical conductivity than any material other than silver, which is too expensive—besides being practically no better in this respect, and less satisfactory in other ways. There are different forms of electrical conductors. Electrically speaking, the solid wire is the obvious form for a conductor of given dimensions. A single solid wire is, indeed, the most suitable where only small gauges are concerned—for a short telegraph line, for instance. When, however, a larger conductor is necessary, its rigidity is soon found to give trouble in buckling through the insulating envelope. The plan of laying up several smaller wires into the form of a strand (Fig. 1) was, therefore, resorted to for the conductor of long telegraph cables, the gauge and number of wires varying with the total length of the line. This is, undoubtedly, the best adapted form mechanically. Electrically, however, it is clearly at some disadvantage, owing to the interstices between the separate wires; and, in order to meet this objection, whilst retaining, in some measure, the mechanical features of a strand, a segmental type (Fig. 2) was adopted by Messrs. Bright and Clark on the first cable to India. But considerable difficulty was experienced in the manufacture of such a conductor; and a little later the late Sir William Siemen's form, shown in Fig. 3, —that of a large wire surrounded by a number of smaller wires—was resorted to, for combining the electrical advantages of a single solid wire with the mechanical advantages of a strand. This is the type now usually adopted for very long cable conductors, whilst the strand form is in universal use for lengths under about 1,000 miles—where the required speed of electrical work does not necessitate the other type. Again, for ocean cables of extreme length, the form shown in Fig. 4, due to Mr. Willoughby S. Smith, has recently been turned to account. The insulating envelope of a cable is almost invariably composed of gutta-percha, the electrical, physical and mechanical qualities of which improve so much from submergence under the depths of the ocean—both by pressure and low temperature.

Vulcanized india-rubber is the only other material which is ever adopted for insulating submarine conducting wires. This is used in the case of cables laid in certain tropical waters invaded by a tiny boring insect called the teredo, and by similar insects possessing a penchant for gutta-percha. The comparative toughness of india-rubber is more than these creatures of the deep can readily negotiate. For submarine purposes, gutta-percha has, however, many advantages over india-rubber under ordinary conditions. In some teredo-ridden waters, gutta-percha is adhered to for the insulation, the core being covered with a thin brass taping (embedded in cotton tape, or threads*) and this is found to be fairly satisfactory.

The thickness of insulating covering is dependent upon the size of the conductor, in accordance with the electrical requirements of the line. It is, in any case, essential to have a depth of insulation such as will obviate the chance of the wire working through, in the course of manufacture, or subsequent cable operations. The mechanical protection, however, varies very considerably, depending on the depth and nature of the bottom. Thus, different types of cable are devised for portions of the complete line. The armor of a submarine cable, like a pit-rope, is composed of a close sheathing of iron wires, having a diameter of 0.07 inches to 0.400 inches, according to circumstances, and varying in number between 10 and 20. For the purposes of after recovery from great depths, tensile strength and lightness are the main objects. A wire of comparatively small gauge, of mild (Bessemer) steel or homogeneous hard-drawn iron, is therefore adopted, such a wire having a breaking strength up to 100 tons per square inch. For shallow water cables, however, the considerations are entirely different Hence, in the type used for shore approaches, large metallic surfaces to withstand abrasion by rocks, &c., together with great weight to withstand lateral (shifting) strains due to strong currents or heavy seas, are of first importance. The increased quantity of metal thus entailed being more than sufficient to withstand all longitudinal stresses likely to be experienced under such conditions, an ordinary class of iron wire ("best-best" quality) of comparatively low tensile strength, say 30 tons per square inch, is employed. The reduced rigidity here obtained is essential on account of the increased bulk. It will be obvious that the iron sheathing would be likely to damage the insulated conductor if applied direct. The gutta percha, or india-rubber, core is, therefore, served with a bedding of jute yarns previous to the laying up of the sheathing wires.

---

* The brass tape is, however, now often applied direct—*i.e.* without any tape or thread underneath.

In any cable, as now made, there are at least three types of construction, namely, the "shore-end," the "intermediate" and the "deep-sea" (or main) cable, the last-mentioned usually constituting by far the greater portion of the entire length. The "shore-end ' is employed, say, for the first 2 miles from each beach, in depths up to about 20 fathoms, the "intermediate," say, to a depth of 200 fathoms, and the "main" type for the remaining portion. Sometimes, however, as many as six different types are necessary for coping with the varying conditions along the route, and it is often found convenient to apply a distinguishing number or letter, to each. The "shore-end" type is, as a rule, furnished with two sheathings, the outer composed of wires of large diameter, with an intervening layer of jute. The weight of such a cable is sometimes as much as 30 tons to the mile. Generally speaking, more or less the same quality of iron is employed for the ordinary "intermediate" type, in a single sheathing of wires of medium, though rather large, diameter. With a view to preserving the iron from oxidation, the sheathing wires are galvanized. In the case of deep-sea types it is also very unusual to apply cotton tape steeped in a bituminous mixture, galvanising not being a very lasting preservative against rust where salt-water is concerned. This preservative mixture is commonly known as Bright & Clark's compound, and is composed of varying proportions of mineral pitch, tar and silica—the latter being incorporated as an extra precaution against the inroads of the teredo. By way of a firm binding and a further preservative, the sheathed cable is, as a rule, finally enveloped in two outer servings of hemp cords, yarns or canvas tape, and then again coated with the aforesaid bituminous compound. (Types of cable, Fig. 5, were shown upon the screen.) In the case of the special shore end these outer wires appear elliptical. In reality, however, they are the ordinary circular wires, but being applied with a very short lay, this appearance is produced in true section.

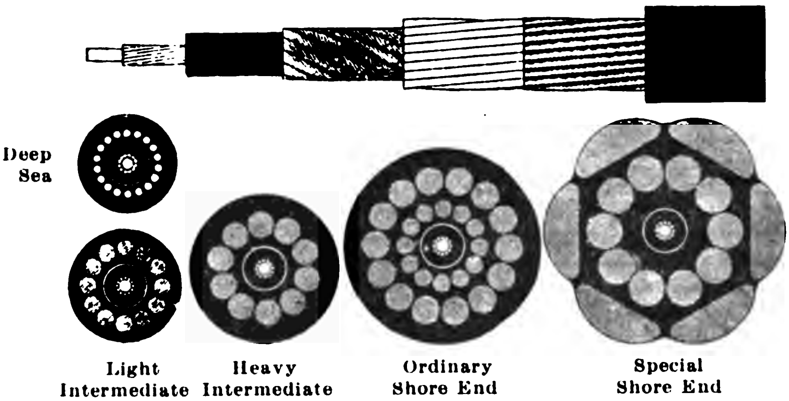

View showing the various Coverings of the Deep Sea Cable.

FIG. 5. MODERN OCEAN CABLE TYPES (Half Scale.)

Shore end cables of this description are now largely used where local conditions demand something specially heavy and offering a large surface to withstand the abrasion of rocks.

Deep sea (main type) cable of the description depicted in the sectional elevation is intended for up to maximum depths of three or four miles, and will bear a strain of 7 tons, with an elongation of at least 3 per cent. Its weight being only about 1 ton per nautical mile in water, it is capable of supporting a considerable length of itself. Thus, a cable can be recovered and repaired in great depths. The form of telegraph cable now in vogue is fundamentally the same as that which was first devised, but other patterns have been tried occasionally, though not with much success. At one time an attempt was made to reduce the weight of deep-sea types by introducing more hemp and less iron. Thus, in the second Atlantic cable each iron wire was enveloped in hemp, but the hemp was soon destroyed by the rusted iron wires which then remained in a loose bundle. A return was thereupon made to the closed sheathed type, which has been adhered to ever since. Steady advance, has, however, been effected in the quality of the materials used, and the available strength of the cable shown on the screen is 30 per cent. greater than that of the Altantic cable of 1865.

—*The Electrician,* December 9, 1910.

JOINTING AND SPLICING

Having dealt with the various types of cable in vogue, the author proceeded to deal with the jointing and splicing operations in uniting two lengths whether of the same type or of different types. Obviously (said the lecturer), these are operations which would form an important feature in any cable work the Navy might have to undertake. Let us first take the joint in the conductor and insulating material. As a preliminary, we must cut away the gutta-percha insulation of the two ends sufficiently to bare the conductor for about an inch and a half from either end. The several wires of the copper strand are now unlaid, and each is pulled out straight at their various angles, care being taken to give them no twist. Each is then separately cleaned either with fine emery paper or the back of a knife blade, more particularly in order to get rid of all the compound used for satisfactorily uniting the insulating gum with the wire. With the aid of a pair of flat-nosed pliers the bared wires are now twisted together again into a true strand for about a third of their length. The entire length of the exposed ends is then, each in turn, dipped into a lump of molten solder on the soldering iron in order to re-unit thoroughly the separate wires of the strand, as so to render them practically *one* wire (Fig. 6). Each end is then filed down to a long tapered wedge or scarf, as shown. The conductor ends are then placed in a vice, the respective scarfs being fitted together and pressed against one another. The two wedge surfaces are next soldered together. Over the joint and one either side for a distance equal to its length are wound two laps of fine tinned copper wire, so as to make the joint firm and permanent and to maintain continuity

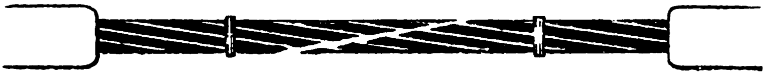


FIG. 6. METALLIC JOINT IN CONDUCTOR

in the case of separation in the scarfed surfaces by failure of the metallic union. The completed joint is then finally soldered over. This work is fairly simple, but the corresponding junction in the dielectric is one which demands considerable care and experience. We will content ourselves here with the more usual case of gutta-percha.

To begin with, the ends of the core should be pared off to avoid joining to the material those portions which have received heat from the soldering iron, and which would not, therefore, join properly to the new gutta-percha about to be appplied. The metallic joint and the gutta-percha ends are next cleaned by wiping over with a clean rag soaked in wood naphtha. The metal conductor is now gently warmed by waving the flame of a spirit lamp underneath. Whilst this is being done the assistant jointer—over another spirit lamp— has softened the end of a stick of what is known as Chatterton's Compound, composed of gutta-percha, resin and Stockholm tar. The jointer now lightly dabs the heated compound along the bare conductor, afterwards spreading the adhering compound evenly around the strand with a warm tooling iron. The joint is now ready for the first covering. This is effected by drawing a portion of the gutta-percha from each end over the joint. The ends of the gutta-percha to be joined are warmed by the lamp—in the same way as with the compound conductor—thereby softening it for nearly 2 inches on each side, the two ends of the gum being gradually drawn down towards one another till about ½ inch apart, until the joint is enveloped in a covering materially thinner than, but nearly as uniform as, the rest of the conductor. The joint is allowed to cool and set for a while. We next warm and tool over the surface preparatory to applying a fresh piece of gutta-percha. A strip of gutta-percha sheet, especially kept for jointing, is then carefully softened over the lamp and a piece cut off. The jointer takes the strip into his fingers and applies it from underneath lengthways. The edges are then raised, and gradually, by a uniform pressure, brought together at the top, so as completely to surround the core. The jointer trims off the excess strip with a pair of bent scissors, and proceeds to apply the iron, heated to the required temperature, to smooth off any inequalities, and complete this second covering by rubbing into shape with the moistened palm of the hand. The third covering is applied to the joint in precisely the same way. In this third covering the strip is longer by an inch or more at each end than the previous one, so as to ensure complete overlapping. When finished, a well-made joint is usually from 6 inches to 8 inches in length. It is now cooled and hardened with water, the whole process from start to finish usually occupying nearly an hour. The work of jointing is of the greatest practical importance in connection with the repair of submarine telegraph cables, hence the length at which I have dealt with this part of my subject. A first-rate jointer is an important factor in the success of the work. I might have gone into still further details in view of how much depends upon the good behavior of the joint.

I will not stop to describe the making of india-rubber joints. The principal difference is that a vulcanising process has to be employed. This is altogether more complicated and more elaborate, and you are not likely to have occasion to deal with the process. Vulcanised india-rubber joints take materially longer than gutta-percha joints, the core itself being composed of different coverings, which require to be more or less reproduced in the joint.*

---

* The whole subject of joints and joint making is fully dealt with in my book, "Submarine Telegraphs: their History, Construction and Working."

We now come to the splice in the armor. This, unlike the joint in the insulated conductor, may be said to be distinctly a sailor's job, being performed on much the same general principles as ordinary hempen ropes. On the completion of the joint as described, the first operation previous to starting on the splice between the two lengths of cable is that of cutting off a sufficient length of the existing inner serving, to avoid a double thickness.* In Fig. 7 you will see that the iron wires (B) have been opened out in preparation for the joint. There are two sorts of splices, applicable for two different occasions. There is the butt or "laid in" splice for joining two cables of similar type, and there is the overlapping splice, for uniting two cables where one is of a materially larger diameter than the other. Turning to the first, let us say that two similar iron-sheathed cables, A and B, are to be spliced together. The outer serving of this cable is stripped off, and the wires unlaid for a certain distance, this depending on the length of splice about to be effected. A given length

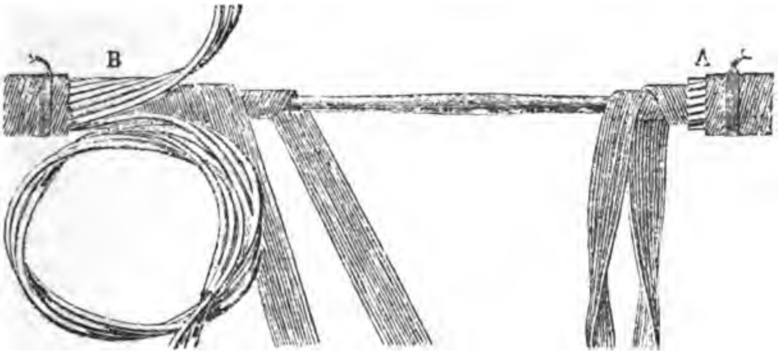


FIG. 7.

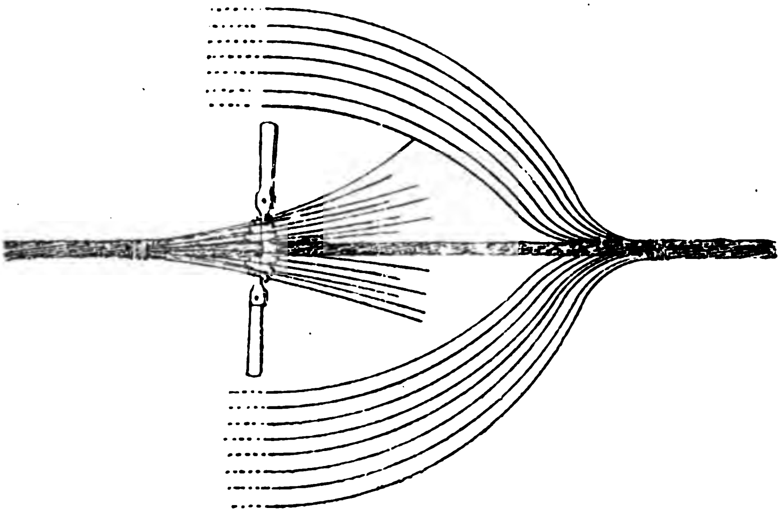


FIG. 8. MAKING LAID-IN SPLICE

---

* As a matter of fact, the preliminary operations associated with the splice are really performed after "opening out"—previous to the making of the joint.

of the core is then cut out—preparatory to making the joint in the dielectric. the splice naturally involving a diminishment in proportion to its length. An iron wire seizing is applied to B, the distance from the end being regulated by the length of splice to be made. If intended for quite shallow water the distance is sometimes only about 10 feet, if for deep water it may be as much as 16 fathoms long. A good rule for the length of splice in a deep sea cable is 1 fathom per wire—*i.e.* so many fathoms according to the number of wires, the object being to avoid the butts between wires coming too close to one another. Fig. 8 shows a laid-in cable splice, unlaying the wires is often accomplished with a splicing tool consisting of an iron collar, pierced with holes and fitted with two handles diametrically opposite to one another. The collar is in two halves hinged at one side, and secured by a pin at the other. Each sheathing wire is passed through a hole in the collar, the core being in the hollow center. A man works the tool along the cable, turning it round the cable the opposite way to the lay of the wires as he advances, whilst the served core passing through the center of the collar, remains stationary. A second "hand" follows with a similar tool at a short distance, in order to retain the wires in their proper relative position. After the joint in the dielectric has been been made it is carefully protected by jute serving built up to the proper diameter, so as to form a suitable bed for the wires. Each iron wire is taken in succession, cut to the required length and laid in as the corresponding wire on the other end is taken out to the necessary distance. All the wires are similarly dealt with in turn, the individual butts being kept about a fathom apart. The splice in the sheathing being completed, one end is held between tongs, the inside diameter of which exactly corresponds to the size of the cable. A man then drives the tongs towards the other end of the splice by means of a hammer, so forcing the wires into their places and giving the cable practically as regular a formation here as elsewhere. The splice finally receives a covering of spun yarn tightly wound round with a serving mallet. This serving should extend at least 3 feet beyond the extreme limits of the splice.

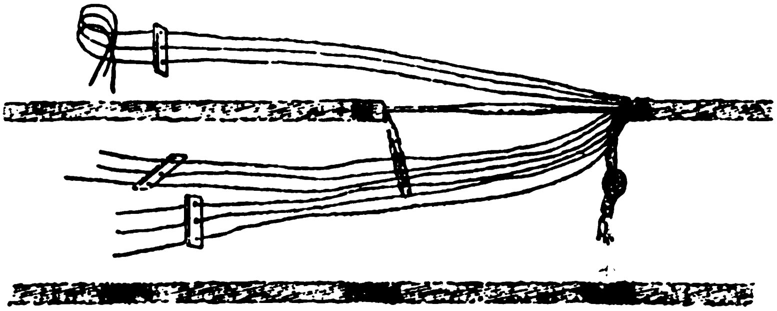


FIG. 9. OVERLAPPING SPLICE

Now, as to the overlapping splice for uniting dissimilar types of cable, or different lays. Let us call A the smaller of two cables, B the larger. The method of procedure will be precisely the same as in the preceding butt splice, until the wires of B have been relaid from B to A. Fig. 9 shows the overlapping splice. Al the wires of B—sometimes two or three taken together—are now twisted spirally round A as before, but without disturbing the sheathing of A. The ends of the B wires are then secured with fine wire seizings at about every fathom, and the whole splice served over with spun yarn as in the preceding operation. This form of splice is often resorted to on emergencies, in cases where it would not perhaps be so suitable as a laid-in splice, chiefly because of the saving in time. As in the case of the joint, technical knowledge has little to do with excellence in cable splicing. The degree of success achieved is mainly dependent on the "hands" who carry out the work; and the best cable hands are those who have been smart and intelligent sailors—often, indeed, hailing from the ranks of the Navy.*

DISPOSAL OF CABLE SECTIONS ABOARD SHIP

Having dealt with the various types of cable, we may consider how you would be likely to find them disposed—or how you would require them to be disposed—in a telegraph ship of which you had occasion to take charge with some definite cable work in view. In the distribution of the various sections of cable on board, it is very usual to ship the shore end and intermediate types in a separate tank from the main type. The foretank is not unusually selected for that purpose, the greater length (and weight) of the deep-sea types being allocated to the main and after tanks, where all the sections in each tank are—as far as possible—spliced up in advance. Indeed, if the requirements are fully known beforehand—to the extent of an actual programme based on a sufficiently thorough survey—it is sometimes possible to splice up the different types of any length of cable some time in advance before arriving on the scene of operations.—*The Electrician*, December 16, 1910.

(*To be continued.*)

◆ ◆ ◆

EFFECTS ON COAST DEFENSE OF THE NAVAL DEVELOPMENTS OF THE LAST FEW YEARS

By "REHABILITATE"

"Fixed defenses are provided for the ports which have been selected as naval bases or coaling stations for the navy, and for other ports, the assurance of whose security is desirable either on account of their strategic value for the protection of trade, or by reason of their commercial importance."

"The forms of attack to which defended ports are liable may be summarised as follows:—

(a). Attack from the sea, which might take the form of—
  (i). Bombardment by battleships and cruisers.
  (ii). Raiding attack by torpedo-boats, destroyers, cruisers, and vessels for use as blockers and boom smashers.
  (iii). Reconnaissance attack.
(b). Raiding attack from the land side."

The two quotations from *Garrison Artillery Training* are given above, the first to define the Coast Defenses with which this article deals; the second to formulate the possible forms of attack. The forms which concern the article will be alluded to as "Bombardment" and "Raid," (a) (i) and (a) (ii), reconnaissance attack being considered as a less or more serious case of either of the others according to its nature and the extent to which it is pushed.

---

* For the fullest description of cable splices, reference should be made to Mr. H. D. Wilkinson's "Submarine Cable Laying and Repairing."

Except for some minor details and for the more complete training of the personnel, Coast Defense has been stationary for some years past; and the naval developments, which amount almost to a revolution in the attack, have all taken place since the successive introduction of the D.R.F., the P.F., the anti-T.B. armament and the B.L. 9.2" on the Mk. V. carriage placed the defense in its present position of excellence.

Before this period of naval activity—in the eyes, at least, of the Garrison gunner—the disparity of defense over attack was quite overwhelming: so much was this the case that our experts considered that Coast Defenses required only 9.2" guns to cope with those of 12" and larger calibers which were carried in the main armaments of the ships. The systems of fire-control and distribution, the methods of range-finding and transmission, the skilled construction of the emplacements and magazines, the careful organization and training, the stable platforms and well-placed lights; all contributed to give the defense complete confidence in their ability to deal with any of the variants of naval attack with a minimum of discomfort to themselves. The general feeling was that the weapons were fully equal to their task.

The naval developments it is intended to discuss are all matters of common knowledge, and have been described and commented on in the Press. British ships are quoted as types, for foreign naval activity has followed very closely on our heels.

A.

The revolution in the design of battleships has brought in on successive waves, the *Dreadnought*, the *St. Vincent*, and the *Orion*. The defenses have now pitted against them larger ships and heavier guns, the armament per ship is greater than before and it is now so disposed as to allow of a larger proportion of it being brought to bear in the desired direction. More ammunition is carried, and by the introduction of suitable rangefinders and methods of fire direction and control, the guns can be fought at long ranges with precision and accuracy comparable, though hardly equal, to that attainable by the use of the P.F. In addition, these ships have greater speed and manœuvring power, their armor is so disposed as to render them less vulnerable than the older types, and facilities are provided in them for rapidly making good disabilities that would arise from the flooding of a compartment. In short, the battleship of today is a very much more formidable antagonist than our defenses were originally planned to withstand.

B.

Cruisers have also advanced in design. The first class armored cruiser possesses the advantages of the new battleship with but small modifications: she is more vulnerable and her armament is not so heavy, but her speed and manœuvring power are greater.

C.

The new ocean going destroyers are fitted with turbine engines; they have greater speed and manœuvring power than the older types: their armaments are greater and their vulnerability is less; they move with less noise and vibration, and consequently with less discomfort to those on board.

D.

The practical perfection and universal fitting of "wireless" enables closer control and direction to be exercised by an officer in charge of an evolution and apprises him instantly of its progress: he is also able to summon reinforcements, and to receive warning of the approach of naval aid for the defense.

E.

The practical submarine increases the difficulty of defense against raid, and compels the defense to call upon the navy to defend themselves in this respect.

F.

The fighting efficiency of the cruisers and battleships of older design has been increased by the introduction of better gun sights, methods of laying, rangefinding, fire direction and control, which bring them more into line with later ships.

G.

Mines are now controlled by the Navy. This takes one burden from the shoulders of the defense, and it is only logical that these dangerous obstructions should be in the hands of those who have to use the water-way.

H.

The re-distribution of our own fleets and naval activity outside our control are the factors which most seriously affect the defense, but these subjects need freer comment than can be given to them within the limits of this article.

J.

Airships and aeroplanes are hardly as yet within practical range, but they loom very large in the immediate future. The Defense will welcome the time when they can be used for reconnaissance, and perhaps also for offensive purposes. In the attack they should not prove so formidable, as they would already have encountered the vicissitudes and fatigue of a journey before they could commence offensive operations. It has elsewhere been suggested that their attack will be easily checkmated by the erection of light steel nettings at suitable heights above vital points.

From the above considerations it is clear that the handicap under which the attack labored has now been reduced; but it is a matter of extreme difficulty to place a definite value on the amount of the reduction. It is believed that naval experts, who should be among the most competent to form an opinion, think that the Coast Defenses are still more than strong enough for all practical purposes; while the officers responsible for the defense are in no way dismayed at the alteration of the handicap, and are prepared to give a very good account of themselves.

BOMBARDMENT

Ulterior considerations (H, above) almost absorb the discussion of this form of attack. The very general opinion seems to be that no attacking force will sacrifice ships of superior fighting efficiency and the necessary amount of valuable ammunition, on the reduction of coast forts, even should the enemy possess the temporary command of the sea. That is the forecast: but it is possible, though perhaps improbable, that a situation might arise from which the issue would hang on the reduction or integrity of a fortress.

In such a case, the attacking force could be expanded to any extent, while the resources of the defense would be confined practically to the guns n position. The attack would, of course, be well acquainted with the locations of all the vital points of the defense, and modern facilities would enable them to pick up their targets with astonishing accuracy. The strength of the defense lies in their stable platforms, their sufficient cover and in the smallness and confused aspect of the targets they would present at the range of a bombardment. The value of this last factor could easily be increased at the expense of but little beyond ingenuity.

Should the handicap be still further reduced, or should circumstances arise in the future to bring the possibility of bombardment within the range of practical politics, the balance can be restored by bringing the caliber of the defense guns into line with those of the attack, and by providing means to reinforce the former by heavy guns on suitable railway mountings, to be run into position over extensions of existing railways, and defended by spade work. For this, an efficient design of mounting and adjustable sight have yet to be devised; they will doubtless be forthcoming when required.

RAID

There is no doubt that this, the most likely form of attack, will now be more formidable than heretofore. But all contingencies should be easily met by the 4″ anti-T.B. guns, the increased efficiency of the gun detachments achieved by systematic training and the more comprehensive and practical systems of intelligence at present in vogue.

To sum up—the moral to be drawn is that the defense must more than ever keep in touch with naval developments and naval methods both at home and abroad; that home and foreign naval estimates and dispositions in the near future will affect the plans of the defense more than any other factors; and that, for the present at least, the Coast Defenses are in a position to do all that may be expected of them, though perhaps not all that they might wish to be able to do.—*The Journal of the Royal Artillery*, October, 1910.

◆ ◆ ◆

EFFECTS ON COAST DEFENSE OF THE NAVAL DEVELOPMENTS OF THE LAST FEW YEARS

By MAJOR C. R. BUCKLE, D.S.O., R.G.A.

Before discussing the effects on coast defense of the naval developments of the last few years we must first consider what these developments have been. They may be placed under the following headings:—

A. Increase in the number of heavy guns carried by battleships with a corresponding increase in the amount of ammunition.
B. The prolongation of the life of the rifling of the guns.
C. Increase in the size of ships, giving increased armament, speed, and protection.
D. The adoption of guns and mountings admitting of guns being fired at longer ranges.
E. Wireless telegraphy.
F. Increase in the size of torpedo craft.
G. Increase in the range of torpedoes.
H. Submarines.
I. Improvements in naval gunnery.

A AND B

The increase in the number of heavy guns and in the number of rounds of ammunition carried by each ship combined with the prolongation of the life of guns can be conveniently considered together as factors which increase the probability of warships undertaking the operation of bombarding a dockyard.

In the days of the "4 heavy gun" ships, a fleet of six battleships carried twenty-four heavy guns, and if for the sake of argument we allow 100 rounds of ammunition for each gun, 2400 rounds of heavy gun ammunition. A fleet of six battleships of the present day type, each ship mounting, let us say, ten heavy guns, carries sixty heavy guns and 6000 rounds of heavy gun ammunition. Let us again for sake of argument assume that it requires an expenditure of 1000 rounds of heavy gun ammunition to destroy the workshops and dry docks in a dockyard and to render ineffective the warships which are undergoing refit at the time of the bombardment. On the conclusion of the operation, the "4 heavy gun" fleet will have fired forty-two rounds per gun and will have 1400 rounds remaining in the fleet; the "10 heavy gun" fleet will have fired seventeen rounds per gun and will have 5000 rounds remaining in the fleet.

It is true that a fleet with full magazines meeting one which has previously expended seventeen rounds per gun has the advantage, but not nearly to the same extent as when it meets a fleet which has expended forty-two rounds per gun of its ammunition.

The increase in the number of guns in a ship also enables a fleet to accomplish the destruction of a bockyard in a shorter space of time than heretofore, and, therefore, exposes the attacking ships to the fire of the shore batteries for a shorter period.

Every round fired from a heavy gun causes erosion in the bore and, therefore, tends to decrease its accuracy; consequently, if a fleet expends a large number of rounds per gun in the bombardment of a dockyard, it is at a great disadvantage as regards its shooting powers when it meets a fleet of equal armament and speed which has comparatively speaking new guns. So much so is this the case that a ship after heavy fighting may require to renew her gun supply as well as coal and ammunition. This being so, the bombardment of a dockyard with a fleet composed of "4 heavy gun" ships was quite out of the question until command of the sea had been obtained.

In recent years, concurrently with the large increase in the number of guns carried by each ship, there has been an improvement in the manufacture of propellants in the British service to such an extent that the life of bores of the guns has been prolonged three, and in some cases, nearly fourfold. Foreign nations consider that they are ahead of us in the manufacture of propellants. A certain Power has recently claimed that her guns have a much longer life than those in the British service. A fleet, provided it attacks in sufficient strength, is not taking nearly the same risks in bombarding a dockyard if it is equipped with guns of "long life" as it would if equipped with guns of "short life."

C.

The increase in the size of battleships affects the coast defense artilleryman in several ways. The advantage that he gains is a bigger target, which not only increases his chances of getting hits, but also enables him to range more than one battery on the same ship at the same time and makes it easier for him to distinguish the fall of the projectiles of one battery from another. All other advantages appear to be with the fleet.

Increase in size means a more powerful armament which has been dealt with above. It also means increased protection to this armament and the vitals of the ship. The battleship of today is so well protected that the sinking of such a ship by the long range fire of the British fortress, armed as it is at present, is quite out of the question. The shore battery might fire hundreds of rounds at a battleship at a range of 12,000 or 13,000 yards without letting a drop of water into her or dismounting a single one of her protected guns. We may possibly set fire to woodwork on the ship and so cause damage, or we may damage the control stations and communications or steering gear; in fact we may impair her efficiency for fighting another ship, but we cannot hope, except by a stroke of extraordinary good luck, to cause a ship sufficient damage to make her desist from bombarding a dockyard which it is our business to defend. Our fire tactics should, therefore, aim at preventing the ship doing damage to the dockyard rather than at sinking her. The fascinating tactics of enticing your enemy to come on and then rising up and smiting him will not do for the coast defense gunner. His duty is the prevention of damage to the dockyard. The batteries he mans are designed to afford the dockyard this protection, rather than to sink the attacking ships. His endeavor, therefore, should be, if possible, to drive off the enemy before he arrives within range of the dockyard, or, if he is unable to do this, to so cover the enemy's ships with smoke and spray when they are firing, that the guns' crews cannot see to fight their guns effectively. High explosive projectiles which burst slightly short of a ship will make a smoke and throw up a spray which, if the fire is intelligently directed with regard to the course of the ship and the direction of the wind, will seriously interfere with the fighting of her guns, whereas projectiles which burst beyond the ship will probably cause no interference at all with her gun fire.

Increase in size means increase in speed. This great speed enables a fleet to traverse the distance between its base and the dockyard which it intends to bombard, or has bombarded, in a shorter time than formerly. This is a matter which affects the probability of bombardment, for it must be remembered that the fighting efficiency of a fleet depends to a large extent upon the condition of the ship's guns as regards the number of rounds they have fired, their ammunition and coal supply, the efficiency of their control communications and the state of their bottoms. After bombarding a dockyard, a fleet would in all probability return as rapidly as possible to its base with a view to refitting before it has to encounter any of the opposing warships.

D AND E.

The adoption of guns and mountings which admit of fire being carried on at ranges of 18,000 yards and upwards is a matter of great importance to coast defense. Concurrently with the great increase in the range at which guns can shoot, we have the introduction of wireless telegraphy which enables the result of fire to be communicated over long distances. Fire to be effective must be observed and corrected. The idea of sending in a "spotting" ship to observe for a fleet bombarding at long range is no longer tenable, for we all realise that a ship which comes within range of the medium armament of the fortress is liable to have some forty or fifty shell per minute bursting round her, which will make both "spotting" and the communication of results an impossibility. "Spotting" from high up in the air will doubtless be achieved in course of time, but at present a fleet bombarding at long range would have to depend upon an observing station on shore from which the dockyard is visible, and from which communications, either visual or by wireless, can be carried on with the attacking fleet. In the absence of an observing party on shore, long range bombardment does not offer much prospect of success, but at some fortresses the establishment of such a station without detection for a few hours does not appear to be by any means an impossibility. After the bombardment has been brought to a successful issue, the fate of the observers is a matter of comparatively little consequence.

Since an observing station has become a necessity for bombardment, it is not a much more difficult undertaking for a fleet to bombard by indirect than by direct fire. Such being the case, unless we can be quite certain at all times of preventing the enemy's observing party placing themselves at any point from which they can overlook the dockyard (the party may be unarmed and disguised in any dress), we may expect bombardment to come from any portion of the water area *within range* of the dockyard. The definition of the term "within range" depends upon the manner in which the guns of the attacking fleet are mounted; the ships of some Naval Powers are capable of firing at a much longer range than those of others. Fire at the extreme limit of range of the guns will be as effective against a large target like a dockyard as that at a shorter range. The greater the distance the attacking ships are from the shore batteries, the less liable are they to suffer serious damage from the fire of these batteries on account of the small striking velocity of the projectiles. The attacking fleet will then probably be from 13,000 to 20,000 yards from the dockyard in that portion of the water area over which the smallest amount of gun fire can be brought to bear by the shore batteries.

The increase in range of the ship's guns gives her greater latitude as to the position from which she can bombard; this may make it necessary to resite such shore batteries as have been designed for fighting in one direction only. The battery which contains more than one gun will very possibly find its fire effect reduced to that of a single gun battery, by reason of the attacking ships being so much on the flank of the battery that only the flank gun can fire without "blasting" other guns in the battery.

Before coast defense batteries can cope with the improvements which have taken place in the defensive and offensive powers of modern battleships, the siting of fire commander's stations, batteries, battery commander's posts and position finders, must be carefully considered. These are at present sited with a view to engaging ships at a range of about 6,000 yards, the idea at the time that they were designed being that battleships would run in to close range with a view to silencing the batteries, and that the batteries would endeavor to sink the attacking ships.

The more intimate relations which now exist between the army and navy have given rise to fresh and it is to be hoped sounder ideas. The dockyard and its contents is now held to be the objective of the attacking ships; these ships, instead of running in to close range, will fire at the extreme range of their guns.

To cope with the guns of the attacking ships our guns must be of such a nature and so sited that they can fire upon the enemy's ships when bombarding the dockyard from any position from which the bombardment is possible. If our guns can be pushed well out in front of the dockyard, it is not necessary that they should be capable of firing at as great range as the guns of the attacking ships, but when, as is sometimes the case, they are close to or even in rear of the dockyard they are designed to protect, they should have as great or even greater range than the guns of the enemy's ships. Equality or superiority in range is a necessity, but equality in striking velocity is not so necessary, for even if we had equality in striking velocity, the ship's armor would still outmatch our guns at extreme ranges. Increase in striking velocity entails a shorter life for the guns and more expensive ammunition. A fleet can effectively bombard a dockyard at a greater range than that at which it would engage another fleet.

A medium gun, provided of course that it can reach its objective, may on account of its quicker rate of fire cause as much or even more interference with an attacking ship's gun fire than a heavy gun.

The exception to this principle is the case of advanced batteries close to which the attacking fleet must pass before they can gain the position from which they will bombard. In such cases striking velocity is of the greatest importance, the role of these batteries is to sink or badly disable ships; interference with the ship's gun fire is of little or no use; the guns should be the heaviest we can mount and the projectiles the best armor piercers we can produce. Hits are essential, "short" rounds are wasted just as much as "overs."

Every heavy and medium gun should, therefore, be mounted singly in a battery by itself in such a position that it has an all round traverse (but not necessarily an all round view over the sights), and it should as a rule be provided with the necessary number of range-finding adjuncts and communications to enable it to fight in every direction both seawards and landwards. A gun may thus have three or four position finders, in cases in which a lesser number cannot be so sited as to cover the whole water area from which a ship could bombard, and telephone communications running to each. It may also have telephone lines running to several observing stations, perhaps two or three miles inland from which fire can be directed landwards. The battery commander should be provided with a horse, bicycle, or other suitable means of rapidly moving to the most advantageous point for fighting his battery. The depression range finder in close proximity to the gun for use when the gun can be layed over the sights should be capable of taking ranges up to the maximum ranges at which the gun can fire. When we have our heavy and medium guns of the fixed armament thus equipped, it will be possible for the nation to obtain full value for the money which has been expended in providing the guns and batteries.

F.

The increase in the size of torpedo craft has enabled them to keep the sea for a longer period and so carry out an attack at a greater distance from their base than formerly.

The increase in size combined with the great speed of such craft facilitates their jumping or breaking through the boom defenses of a harbor, so that it is of the utmost importance that the anti-torpedo-boat defenses should be capable of stopping boats before they reach the harbor's entrance.

G.

The increase in the range of torpedoes enables the attacking boats to discharge their torpedoes at a distance of some 4000 to 5000 yards from their objective, so that, if they could see at such a distance, the boats would never come within the range of the electric defense lights. This increase in range, however, does not effect coast defense much in the case of a night attack, because the boats must still come close enough to see their objective before they discharge their torpedoes, and, therefore, they will usually have to come well within the illuminated area or zone of the searchlights.

With these long range torpedoes, however, under certain conditions an attack by day instead of by night might possibly offer some prospect of success. If the anti-torpedo-boat defenses consist of low sited guns, the limit at which these guns can be fought with effect by means of auto-sights will not exceed 2500 yards; under such conditions a boat travelling at 30 knots is less likely to be hit at a range of 5000 yards by day than she is at a range of 1500 yards by night. But here again nature comes to the assistance of the defense. In the vicinity of the entrances to harbors which are protected by moles and breakwaters, the tides and currents are almost always strong and variable, so much so that a torpedo fired at long range at the harbor's entrance has little or no chance of hitting its mark. An attack by torpedo craft by day then is possible under certain conditions, but highly improbable in the case of most British harbors.

H.

The employment of submarines has hardly emerged from its experimental stage so that it is somewhat premature to discuss their effect upon coast defense. Their presence in the vicinity of a harbor would undoubtedly place a greater strain upon the personnel of the anti-torpedo-boat defenses, for it will be necessary for the gun detachments to be constantly on the alert by day as well as by night. It will perhaps be found necessary to double the manning details allotted to these guns.

It has been suggested that the submarines of the defense will be capable of keeping off battleships from bombarding a dockyard from the portions of the water area upon which the shore batteries cannot bring any fire to bear. *If* such be the case, the defense of the whole water area by day should be entrusted to submarines, the offensive defensive is always the more effective method of dealing with an attack; and the heavy guns of the fortress may confine themselves to dealing with an attack from the land side and supporting the medium guns at night. But it is early days yet to admit that submarines have such a large sphere of usefulness in the defense of a dockyard as to enable us to dispense with heavy gun fire seawards.

Possibly the submarines of the defense will find an opportunity of attacking hostile ships when the latter are under fire of the guns of the fortress.

I.

Improvements in naval gunnery will no doubt have the effect of making the fire of attacking ships very much more accurate and, therefore, more effective in a given time against the objective upon which it is directed. At the same time it has taught the personnel of the ships that uncontrolled fire is not of much value and, therefore, so long as the control stations remain intact, it is improbable that a ship will engage a greater number of objectives than she has control stations.

The defense then, if some of the attacking ships fire on the shore batteries with a view to assisting others in bombarding the dockyard, will greatly benefit by the dispersion of their guns in single gun batteries. A ship with two control stations could engage two 3-gun batteries at the same time, whereas to engage six single gun batteries three ships are required. To be able to fire upon your enemy without being fired on yourself is a very great advantage. If the shore batteries can divert the fire of attacking ships from the dockyard on to themselves they are for the time being fulfilling the purpose for which they were designed.

In conclusion, it appears that it is upon the heavy armament of a fortress, and the method of fighting this armament, that naval developments have had such a great effect. To cope with these developments, the nature of the heavy armament and the manner in which it is mounted, the siting of the armament, and the provision and siting of range finding adjuncts requires careful reconsideration to meet the new conditions.

The two questions to be decided are:—

A. What number of guns firing as rapidly as possible are required to render the fire of a modern battleship ineffective?

B. What number of hostile battleships in a fleet which is bombarding the dockyard can fire on the dockyard at any given moment?

The answer to A multiplied by the answer to B determines the volume of gun fire which a coast defense fortress should be capable of bringing to bear upon bombarding ships. The answer to B will usually be greater when the ships are using direct fire than when they are compelled to use indirect fire.

Looked at from a national point of view, the situation is none too bright; but from the point of view of the Garrison Artilleryman, the chances of his having to fight his guns are far less remote than they used to be. Not only have recent naval developments tended to make an attack on a dockyard a more probable contingency than heretofore, but the command of the sea is becoming less and less a British monopoly. Should we be engaged in a European war in the near future, there is a reasonable prospect of one or more of our coast defense fortresses being called upon to keep off the enemy's ships for a time. Here the Garrison Artilleryman will take his part in the first stage of the war. Later, after the navy have obtained command of the sea, he will lay aside his defensive role, and equipped with movable heavy guns and howitzers, carry the war into the enemy's country and once again live up to his motto, *Ubique quo fas et gloria ducunt.*

—*The Journal of the Royal Artillery*, November, 1910.

◆ ◆ ◆

NAVAL AND MILTARY PROGRESS IN 1910

The interest of the year in naval matters has centered in the question of the relative strength of the powers in ships of the dreadnought class. Rightly or wrongly, it has come to be accepted as a truism that the naval power which is strongest in vessels of this class, no matter what its strength may be in warships of the pre-dreadnought era, must necessarily be the leading naval power. Hence, it has come to be the fashion to speak of the dreadnought as a revolutionary type, which has almost wiped out the existing fleets from serious consideration. The *Scientific American* has always questioned, and still does, the soundness of this view. The first shock of battle between the dreadnoughts will be so destructive that victor and vanquished alike will find their first line of battle terribly crippled; and it seems to us that the final issue of the struggle will lie with that nation which can bring up the strongest second line of battleships of the *Connecticut*, *King Edward* and the *Deutschland* class. At the present writing, the rating of the great powers in dreadnoughts is as follows: Great Britain leads with 11 completed and 11 under construction; Germany, ranking second, has five completed and twelve under construction; she is followed by the United States, with four built and four in course of construction. France has no ships of the strictly dreadnought class in commission, and has but three under construction. Japan has built two, and has two in hand. Russia is building four dreadnoughts, but has none completed. Italy is in the same condition, while Austria is building two of this class. In battleships of the pre-dreadnought type, Great Britain leads with 49, followed by the United States with 25, Germany with 22, France with 17, Japan with 12, Russia with 8, Italy with 9, and Austria with 5 battleships. In the foregoing estimate of dreadnought strength we have included with the battleships all armored cruisers carrying exclusively a big gun armament. In armored cruisers of the pre-dreadnought period, Great Britain leads with 34, followed by the United States with 12, Germany with 9, France 21, Japan 11, Russia 7, Italy 10, and Austria 3. When the vessels now under construction are completed, the rank and tonnage of the navies will be as follows:—Great Britain, 2,173,838 tons; Germany, 963,845 tons; United States, 824,152 tons; France, 725,231 tons; Japan, 493,671 tons; Russia, 401,463 tons; Italy, 327,059 tons, and Austria, 309,899 tons. The advance in size and power of battleships has been simply astounding, and no one ventures to state what will be the limit. The latest battleships building for this country, the *New York* and *Texas*, are to be of 27,000 tons, mounting a new 14-inch gun. The *Lion*, a British 28-knot armored cruiser, 660 feet in length, and carrying eight 13.5-inch guns, will be of 26,500 tons displacement, and a larger *Lion* is being planned of 28,000 tons, which is to be at least 700 feet in length, and of 30 knots speed. The Argentine ships, built in this country, are of 28,000 tons, and Armstrongs are now building for the Brazilians a huge vessel of 32,000 tons, which will carry an armament of twelve 14-inch guns. Already, there is semi-official talk in this country of building a ship of equal or greater displacement carrying 16-inch guns. One result of the re-introduction of guns of this caliber will be an immense increase in the displacement of future battleships. Due largely to the vigorous policy introduced by Secretary of the Navy Meyer, there has been a marked increase in efficiency in the ships of the U. S. navy that are in commission, and particularly has this been noticeable in the engineering department. Our latest battleships are not only living up, in service, to their contract speeds, but frequently have exceeded them. In 4-hour trials at full power, the *Louisiana* recently made 18.9 knots, and the *Michigan* 19.4 knots, which is about a knot more than the contract speeds. Except in the cruiser-dreadnought class, and in the class of scouts of from 3,000 to 5,000 tons, the cruiser type is no longer being built by any navy. The latest scouts showed 26 knots or more on their trials. As regards torpedo-boat destroyers, the tendency is to build larger and more seaworthy vessels of moderate speed, say of 27 to 30 knots. Our own vessels of the *Reid* class have been showing remarkable results under oil fuel, making on trial 32 knots and over. The submarine is forging steadily ahead in reputation, and is today readily controlled and, within its limited range, of undoubted efficiency. That it will some day be able to accompany the battleship fleet on the high seas is indicated by a recent voyage of 1,500 miles from Cape Cod to Bermuda and back, accomplished by the United States submarine *Salmon*. Toward the close of the year, moreover, a French submersible covered over 3,000 miles during an ocean cruise, in which the little craft was unattended. The work of providing adequate coast fortifications has been carried to a point at which our defenses may be considered to be fairly complete. The full efficiency of these fortifications, however, is not realized, because of the lack of proper mine equipment, and the usual accessories for the mines and guns already in place. To provide for these accessories would involve an expenditure of about fifteen million dollars. The army, in common with the navy, has had some trouble with its heavy artillery, chiefly in the premature ignition of the charge and blowing open of breech blocks, or the bursting of guns. The former is to be remedied by a more perfect system of safeguards, and the latter by extending the hooping of the guns entirely to the muzzle.

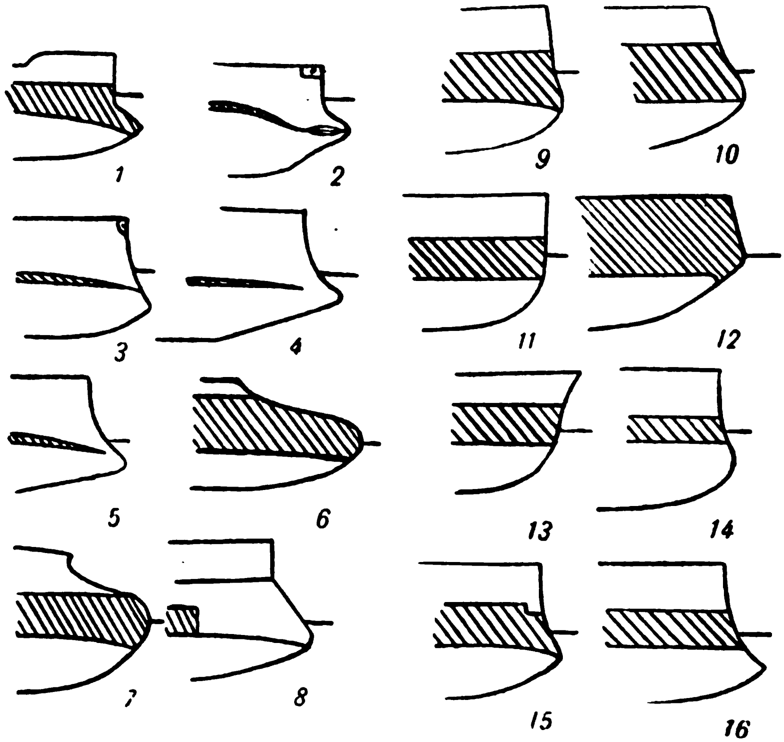
—*Scientific American*, December 31, 1910.

✦ ✦ ✦

THE RAM BOW

Translated by 2nd Lieut. E. J. W. Ragsdale, C.A.C.

The *Naval and Military Record* publishes an article on the value and development of the Ram Bow. Not only has the Ram lost all of its usefulness due to the increased range of fire and the development of the torpedo, but in case of accidental collision might even lead to disaster. France and Japan have both done away with it entirely, and the other powers have only retained it as a means of increasing the waterline length for the purpose of



greater speed. The South American States, however, with the small number of ships in their Navies, have strong hopes of being able to use the Ram at close range and in consequence have developed a more pronounced type. The sketches on page 94 illustrate the chief forms of Rams that have been used. They are:

1. *Dreadnought*, British Battleship, 1875.
2. *Trafalgar*, British Battleship, 1887.
3. *Centurion*, British Battleship, 1892.
4. *Canopus*, British Battleship, 1897.
5. *Arrogant*, Britsh Torpedo-Ram Cruiser, 1896.
6. *Dupuy de Lome*, French Protected Cruiser. 1890.
7. *Gaulois*, French Battleship, 1896.
8. *Rurik*, Russian Protected Cruiser.
9. *Dreadnought*, British Battleship, 1906.
10. *Nassau*, German Battleship, 1908.
11. *Jean Bart*, French Battleship, 1911.
12. *Poltava*, Russian Battleship, 1911.
13. *Kawachi*, Japanese Battleship, 1910.
14. W*yoming*, United States Battleship, 1910–1‘ 11.
15. *Moreno*, Argentine Battleship, 1911.
16. *Minas Geraes*, Brazilian Battleship, 1908.

—*Schiffbau*, September 28, 1910.

◆ ◆ ◆

WARSHIP ARMAMENTS

By Percival A. Hislam

(Abstracted)

* * * * * * *

In the *Neptune*—after seven *Dreadnoughts*—we get for the first time a full broadside in a battleship of the new type, but still not altogether a satisfactory one. It is in the *Orion* that we find this for the first time. Leaving the difference in caliber out of consideration—the *Orion* will carry ten 13.5-inch to the ten 12-inch of the *Neptune*—the gun-fire of the two is as follows:—

	Neptune.	*Orion.*
Ahead	6	4
Astern	8	4
Broadside	10	10

The *Orion's* guns are much more efficiently disposed for broadside fire than those of the *Neptune*, for while the latter has two turrets *en echelon* the *Orion* has her five all on the center-line. To secure this advantage the *Orion* sacrifices two guns ahead and four astern. What the actual gain on the broadside is we cannot know until we have complete details of the angles covered by the various turrets, but a discussion on somewhat similar lines has recently been taking place in America, the point at issue being the respective merits of the United States *Wyoming* and *Arkansas* and the Argentine *Moreno* and *Rivadavia*. Both types carry twelve 12-inch guns; but while the North American ships have all their turrets on the center-line the Argentine vessels have two turrets *echeloned* amidshlps. The result may be expressed thus;—

	Arc of Fire on each Beam.	
	Wyoming. Deg.	*Moreno.* Deg.
1st Turret from forward	150	150
2nd " " "	135	135
3rd " " "	140	180 starboard 100 port
4th " " "	150	100 starboard 180 port
5th " " "	165	135
6th " " "	150	150

The net result is that the *Wyoming* can cover 95 degrees on either broadside with her twelve guns, while the *Moreno* can cover only 85 degrees. With ten guns the *Wyoming* can sweep an arc of 120 degrees and the *Moreno* 105 degrees only; while for eight guns the figures are for the *Wyoming* 135 degrees, and for the *Moreno* 120. Against this, the *Moreno* can fire eight guns ahead or astern to the *Wyoming's* four. It is probable that these figures are more or less true for the broadside fire of the *Neptune* and *Orion*. If they are, the point for discussion is whether an advantage of 11.7 per cent. on the broadside is worth an inferiority of 100 per cent. in astern and 50 per cent. in ahead fire.

The question of internal combustion engines is held by some to affect this question very closely. It is doubtful whether it will actually do so, although it will, of course, vastly increase the fighting efficiency of ships in other directions. In the paper with which he may be said to have broached the subject three years ago Mr. James McKechnie gave a plan of a ship equipped with internal combustion machinery and armed with ten 12-inch guns. The arcs of fire were as follows:—

	Port.	Starboard.
Turret No. 1	135	135
" No. 2	90	180
" No. 3	120	125
" No. 4	180	90
" No. 5	135	135

That is, the 10 guns are only available through an angle of 90 degrees on either beam, or five degrees less than the arc covered by the six turrets of the *Wyoming*, and certainly less than the arc of the *Orion's* five. The gas-engined ship described could fire six guns either ahead or astern, but only four in both directions at once, which is equal to what can be done by the *Wyoming* or the *Orion*.—*The United Service Magazine*, November, 1910.

✦ ✦ ✦

A NEW METHOD OF MEASURING THE STRENGTH OF MAGNETIC FIELDS.*

By Prof. W. Peukert

The property of bismuth, which changes its resistance in a magnetic field, is well known, and measurements can be carried out by means of the bismuth spiral, made by Hartmann & Braun. The method here described depends on the Hall effect, which is specially noticeable in bismuth. Suppose current, furnished by a source, E, to pass through a bismuth plate *abcd* from

---

* Abstract of an article in the "Elektrotechnische Zeitschrift."

a to *b*, and that the points *c* and *d* lie on the same equipotential line, then no current will flow through the galvonometer *g*. If the magnet NS is excited, this is no longer the case, the equipotential lines being shifted. If *e* is the voltage between *c* and *d*, H the strength of the field and *i* the current passing from E, then

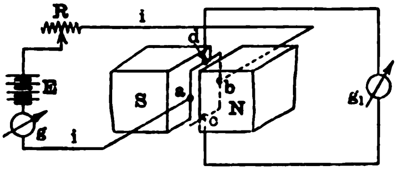


Fig. 1. Showing the Connections for Measurement

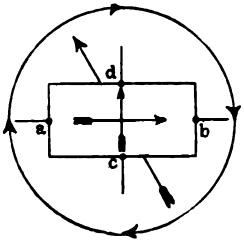


Fig. 2. Showing the Direction in which the Equipotential Lines are Displaced.

$$e = \frac{C i H}{d}$$

where *d* is the thickness of the bismuth sheet and C is a constant, depending on the nature of the material. A. von Ettingshausen and Nernst showed

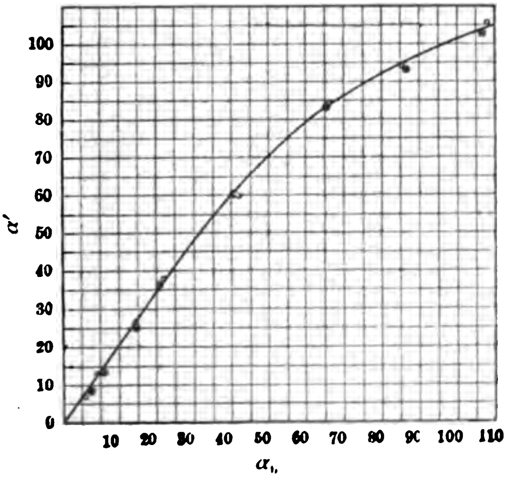


Fig. 3. Showing the Relation Between the Transverse Electromotive Force and the Field Strength

that in order to produce the maximum effect there must be a definite relation between the length and breadth of the sheet, otherwise the current, which would flow transversely, tends to flow round the edges into the primary circuit. The direction in which the equipotential lines are displaced is shown in Fig. 2, and depends on the direction of the magnetic field and the current from *a* to *b*.

The experiments were made with a bismuth sheet, 68 mm. long, 28 mm. broad and 1 mm. thick, the connections being made by thin copper wires soldered to it. The sheet was first exposed to a constant magnetic field, the current *i* being varied. It was then found that the deflections shown on a Deprez mirror galvanometer were precisely proportional to the current *i*, which was gradually raised to 1.5 amperes. The amount of the deflection depended on the direction of the magnetising current through NS, and this was doubtless due to some slight want of symmetry in the bismuth sheet; and even when no current passed from *a* to *b* there was still a small deflection, due probably to some thermo-electric effect. To determine the relation between *e* and H the current *i* was kept constant, while H was varied. Close to the sheet of bismuth was a small coil, the ends of which were connected to a ballistic galvanometer, the deflection on which, α_b, was taken as being proportional to the strength of the field, I being the actual value of the magnetising current; α_1 and α_2 are the deflections of the mirror galvanometer, depending on the direction in which the current *i* flows, α' being deduced therefrom, having regard to the want of symmetry in the sheet, and being taken as proportional to the voltage produced. The results are given in the appended table, and are also shown in the curve, the ordinates being the values of α' and the abscissæ being the deflections shown by the ballistic galvanometer.

i amperes.	I amperes.	α_b mm.	α_1 mm.	α_2 mm.	α' mm.
0.00	0.0	0.0	0.0	— 0.0	. .
1.50	0.0	0.0	5.0	— 5.0	0.0
1.50	1.0	5.8	13.0	— 12.0	7.2
1.50	1.5	9.9	18.6	— 18.0	13.0
1.50	2.0	19.4	32.0	— 31.0	26.2
1.50	3.0	27.5	44.0	— 43.0	38.2
1.50	5.0	47.0	66.0	— 65.0	60.2
1.50	7.8	71.5	90.0	— 89.0	84.2
1.50	12.0	90.5	100.0	— 98.0	93.7
1.50	20.0	113.0	112.0	— 110.0	105.3
1.50	0.0	0.0	6.0	— 5.4	0.0
0.00	0.0	0.0	0.0	0.0	. .
1.50	— 1.0	— 7.5	— 3.0	2.5	8.8
1.50	— 1.5	— 10.6	— 7.0	8.0	13.6
1.50	— 2.0	— 19.4	— 19.5	19.0	25.3
1.50	— 3.0	— 25.9	— 30.0	31.0	36.6
1.50	— 5.0	— 46.0	— 55.0	54.5	60.8
1.50	— 8.0	— 70.2	— 76.5	78.0	83.3
1.50	— 12.0	— 96.5	— 87.0	87.0	93.1
1.50	— 20.0	— 112.0	— 96.0	97.0	103.0
1.50	0.0	0.0	6.5	— 6.5	0.0
0.00	0.0	0.0	0.0	0.0	. .

In this case the direction of the magnetic field seems to make no difference to the results, so that any want of symmetry in the bismuth sheet seems to make little difference in the extent to which the equipotential lines are displaced if i is constant.

If a curve of this kind is once constructed, it is easy to see that the measurement of the strengths of different magnetic fields can be made at once. The calibration curve must be so constructed that it shall be possible to determine at once the absolute strength of the field, the only instruments required being an ammeter and a sensitive galvanometer. The Hall effect can therefore be used for measurements of this kind, and the simplicity of the method makes it appear to have many advantages as compared with others at present in use.—*The Electrician*, November 25, 1910.

◆ ◆ ◆

EXPLOSION GASES AND THEIR EFFECTS ON MAN *

This question has received special consideration since the naval battles of the Russo-Japanese War. During mining operations, the men in the galleries show a variety of symptoms, termed "mine-disease." Fatigue, weakness, cramps, nausea and occasionally complete unconsciousness, are among the consequences noted. Some were fatal, but not many. When brought to fresh air, they usually recovered at once.

Attempts to remove the trouble began with search for the particular gas which produced the trouble. Finally, the discovery of the presence of CO in the blood of those who died, gave a clue to the cause.

* * * * * * *

"On board a man-of-war there are three sources from which poisonous gases may be derived and endanger the well-being of the men: (1) The smoke from burning cartridges, (2) the spontaneous combustion of ammunition, and (3) the explosion of the enemy's shells and the resulting gases spreading in the ship and penetrating into the living spaces of it.

"Observations on nitro powder show that the smoke produced from it, while less in amount than that from black powder, is still sufficient to interfere with gun sights and the comfort and well-being of the men. Attempts to reduce the quantities of all combustible substances in the cartridge have lessened, but not removed, these inconveniences. As a practical example, our author quotes from a report by the French naval surgeon Gazeau, published in the Arch. de Med. Navale, 1907, as follows:

'During practice firing in June, 1906, with the wind aft and with conditions under which the smoke could not be promptly removed, the men in the turret became wrapped up in a cloud of smoke so dense that the individual members of the gun crew could not be distinguished. Although the rapidity of fire was thereby much impaired, the firing was continued to the end. At the end of the practice the entire crew gun was found in a condition that would not have permitted its remaining in such smoke for even a few minutes longer without dangerous consequences. The men complained of headache, neckache, dizziness, so pronounced that some of them fell on leaving the turret, vomiting recurring even during the afternoon of the same day. As a preventative, an arrangement for the supply of compressed air was demanded.'

"Accidents of this kind can be prevented only by mechanical means, but it also becomes of considerable importance to note whether the combustion of nitro-powders is complete or incomplete. During the incomplete combustion certain oxides of nitrogen are formed, which are further oxidized to nitric and nitrous acids providing air is admitted, and which gives a dense yellow nontranslucent smoke, strongly irritating the eyes and the breathing organs of the men. The ammonia powders are attended by a more complete combustion, and the various oxides of nitrogen are not present in such smoke."

---

* The parts of this article in quotation marks are taken from a translated summary in U. S. Naval Medical Bulletin. October, 1910, of an article by Dr. H. Trenbur. "*Marineoberstabsarzt*," entitled "*Explosions-gase und ihre Wirkung auf den Menschen.*"

* * * * * * * * *

"Of still greater importance to naval surgeons are the gases which in future naval battles will be introduced into ships through the explosive shells. The more perfect in construction the explosive shell becomes the more certain the fact that we shall have to reckon with its explosion after piercing the armor in the interior of ships and the more likely it is that we shall in the future have to deal with the effects of poisonous gases on the men during an engagement.

"The slightly varying composition of the charges employed by different nations can have but little influence on the products of explosions, especially since picric acid has been displaced in their manufacture by the more resistant and the more difficultly detonizable trinitrotoluol $[C_6H_2CH_3(NO_2)_3]$.

"For questions interesting medical men the knowledge of an accurate composition of the charges of explosives is not of much importance on account of the products of their decomposition being about the same in all. The decisive constituent is oxygen. The more oxygen is present during the explosion the more completely the carbon and hydrogen present will be oxidized into carbon dioxide and water, while in the case of a deficiency in oxygen the combustion will be less complete and the more hydrogen and carbon monoxide will be present in the final smoke produced. The rapidity of combustion likewise influences the completeness of the oxidation occurring in the charges. Trembur gives the following analyses obtained by Lewin and Poppenberg of the gases resulting from different explosives during their combustion:

	CO.	CO_2.
	Per cent.	*Per cent.*
Nitrocellulose	46.9	16.8
Gelatinedynamite	34.0	32.6
Carbonite	36.0	19.2
Ammonol	23.7	6.1
Picric acid	61.1	13.5
Trinitrotoluol	57.0	1.9
Coal dust	.34	6.7
Illuminating gas	4.6-10.0	3-8.0
Water gas	41.0	4.0
Mine gas	3.8	52.0

* * * * * * *

"Carbon monoxide, on account of its greater affinity for hæmoglobin than oxygen, takes the place of the latter in the hæmoglobin molecule, interfering with the free distribution of oxygen in the organism, thus practically depriving the organism of its oxygen for the time being. When 50 to 75 per cent of the red blood corpuscles are charged with CO instead of with oxygen, death is inevitable.

"Although an absolutely sure case of poisoning by CO from explosive gases has not yet been recorded, experiments on animals by Lewin and Poppenberg leave no doubt as to the correctness of this assumption. When the animals were placed in a box, in which either picric acid or trinitrotoluol was exploded, the symptoms that followed were in either case those of CO poisoning. Whenever the air of the room contained 0.33 per cent of CO a paralysis of the hind legs occurred after an exposure to the gases of eleven minutes, and recovery without interference was impossible."

* * * * * * *

"It is indeed strange that not a single undisputed case of death due to this cause has been made known to us during the entire Russo-Japanese war, and even the records of cases of sickness due to explosive gases are very meager and the inferences drawn from them indefinite and uncertain.—(H. G. B.)"

◆ ◆ ◆

SOME REMARKS ON WET GUNCOTTON

By Bt. Major R. L. McClintock

While instructing Infantry and Cavalry classes in the art of demolition, the writer has frequently encountered the apparently widespread idea that wet guncotton is so stable and reliable an explosive, that any failure on its part to detonate properly is entirely the fault of the maker-up of the charge. Consequently, the misbehavior of any wet guncotton used in such demonstrations, serves to supply the usual merry jest at the expense of the operator in particular, and the Corps in general.

It is an unhappy fact, however, that wet guncotton which has been stored for a long period in a tropical climate becomes unreliable, and is, in course of time, as likely to burn as to detonate properly, and this no matter how tightly the primer may be in contact with it, and however efficiently the latter may explode. This statement will probably be heartily endorsed by any R.E. officer who has had the misfortune to come across any of the very old wet guncotton to be met with sometimes in India. To quote an extreme case, the writer was recently told by an officer just back from delivering a course of demolition lectures at various garrisons on the N.W. Frontier, that about half the wet guncotton given him for the purpose from one local magazine could not be detonated under any circumstances.

Now, the failure of a charge in peace is at worst a matter of a jibe at the operator, but in war it is another story. On a frontier campaign it may mean the delay of an hour in the retirement of a hard-pressed rear guard, or the abandonment of the demolition for which, perhaps, the day's operations had been undertaken.

The writer had been aware for a long time of this failure of old wet guncotton, but its extreme undesirability was strongly brought home to him early in the present year, the occasion fortunately being the peaceful one of an Indian field day. The attached photos illustrate the events.

The general idea was the forcing of a defile, the destruction of a frontier tower (prevously built for the occasion, *Photo* 1), and the withdrawal of the force on the completion of the demolition. On the appointed day, the defile having been duly forced and the heights beyond occupied, the Sappers and Miners engaged the tower. The charge (21 lbs.) was placed in the orthodox way in a hole excavated in the raised floor of the tower, fully tamped and provided with duplicate firing arrangements. The wet guncotton used was part of the service equipment of the Sapper and Miner Company concerned, and the slabs bore the impress of "1886." The fuzes were duly ignited but, although the explosion of the primers was distinctly audible, the wet guncotton failed to detonate, and only decomposed instead with the evolution of dense volumes of dark red nitrous oxide (*Photo* 2). Again a similar charge (the remainder of the same box of wet guncotton) was placed and fired in precisely the same manner—and with a precisely similar result. A third effort was made with some new wet guncotton (dated "1907") borrowed from another unit, and the tower at last successfully demolished (*Photo* 3).

Now, had this been service, and the same wet guncotton have been used, the same failures would have followed. Whether any further disasters would have ensued it is impossible to say, but the probability is that this protracted delay would, quite possibly, have prevented the column from reaching its proper camp that night.

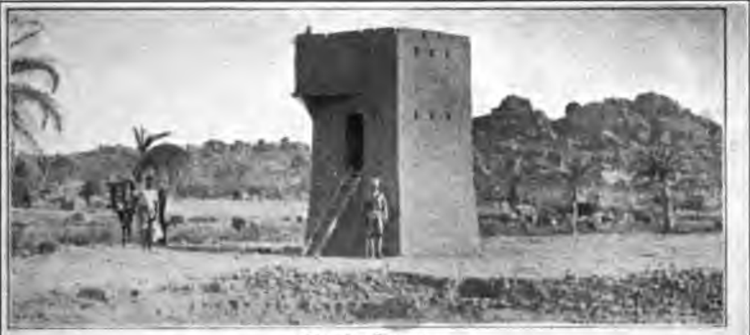
It is surely desirable, therefore, that the question of the deterioration of wet guncotton in tropical climates should receive expert attention, and that all wet guncotton of more than a certain age be cast as being untrustworthy, or returned to the laboratory for testing. What that age is, the writer has not sufficient experience even to suggest, but if ordered on service he would without doubt make a strong effort to get rid of all his wet guncotton of more than 15 summers to somebody else.

It is practically impossible for the O.C. of a unit to carry out any periodical tests of the reliability of his wet guncotton, short of opening each box on his charge and actually firing one of the slabs. To open, however, a hermetically-sealed tin-soldered case of wet guncotton for such test, and then reseal it in the only available manner with a tape and varnish makeshift is hardly practicable in a hot climate, and would only add to its chance of being useless when really required.—*The Royal Engineers Journal*, November, 1910.

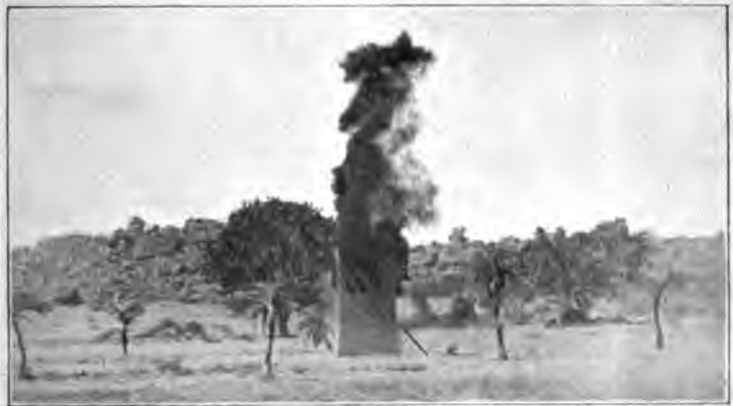
Short Notes

Main Battery Arrangement of the Orion.—With the launching of the *Orion*, the British Navy has its first battleship with all her big guns on the center line of the ship. The United States Navy is several years ahead of the British in this regard, as all the recent battleships of the American Navy have their main armament arranged upon this principle. Discussing this subject, the *Naval and Military Record* says:—

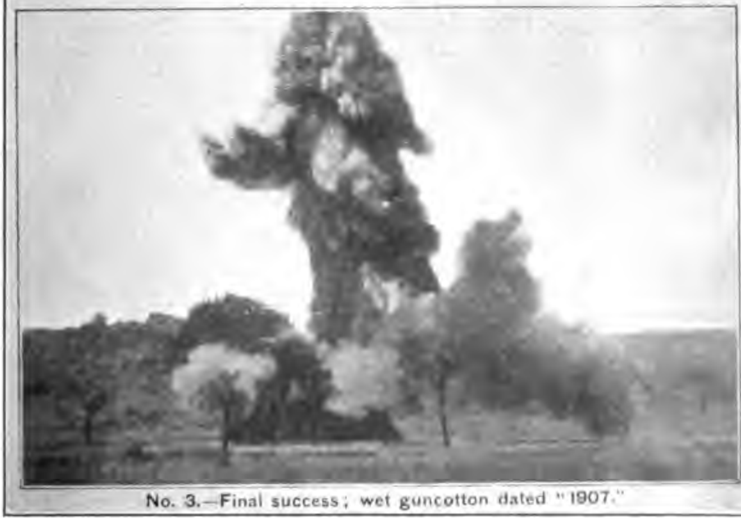
The tendency has, of course, been in that direction since the *Dreadnought* type was first introduced; in fact, the type itself is based largely on the fact that modern tactics demand broadside power before anything else. In the United States all ships of the all-big-gun type have been designed with full broadsides, and in each case the turrets—four in the *Michigans*, five in the *Delaware* and *Floridas*, and six in the *Wyomings*—are mounted on the center-line of the ship. There is no doubt as to the efficiency of the practice, and although we have seven *Dreadnought* battleships which are able to concentrate only eight of their ten guns on either broadside, the deficiency—for it seems to merit that name—has been remedied partially in the *Neptune* and wholly in the *Orion*. It was seen from the first that as a ship is a compro-



No. 1.—Tower.



No. 2.—Failure No. 1; wet guncotton dated "1886." Dense red fumes of NO_2 evolved.



No. 3.—Final success; wet guncotton dated "1907."

mise of sacrifices, so a broadside of a hundred per cent of the armament would only be obtained by a sacrifice in other directions. The *Neptune* is an apparent exception, for she can fire as many guns ahead as the *Dreadnought*, and two more (eight) astern; but, on the other hand, the echelon arrangement of the midship turrets, which alone makes this possible, is itself not the most advantageous for broadside fighting, since the port turret can cover only a small arc on the starboard beam and *vice versa*. The *Orion*, which has as efficient a broadside as we are likely to obtain—except, of course, in so far as a greater number of turrets may be mounted—is a better instance of the sacrifices demanded by a full broadside. She can fire only four guns ahead or astern to the *Dreadnought's* six, while the *Neptune*, which has the advantage of a super-posed turret aft, can fire eight guns in that direction. Bow and stern fire, however, are well and wisely subordinated to the broadside."

—*The Navy*, October, 1910.

Englands Latest Battleship-Cruiser.—The new cruiser *Indefatigable's* trials are said to have demonstrated that she is a very fine sea boat in rough weather. The *Indefatigable*, by the way, is a ship about which very little is known. There is a sort of idea that she is something altogether superior to the Invincible class, where, as a matter of fact, she is merely a slight development of them. The principle differences are that she is 25 feet longer, thus avoiding the cramped position of the amidship turrets, which is the weak point of the *Invincibles*. She is 18 inches wider, which makes her a trifle finer than the *Invincibles*. She has 2000 more horse-power, and as she is 1500 tons heavier it is improbable that she will prove to be materially faster than her predecessors. This is a fact which should be kept in mind, because unless she attains a very high speed quite a number of people will imagine her to be a failure.—*The Engineer*, December 16, 1910.

First Italian Dreadnought.—The *Dante Alighieri*, the first of the new type of Italian battleships, which was recently launched, is attracting much interest on account of her arrangements of triple turrets. The ship displaces 19,250 metric tons, and is 510 feet long with 85 feet beam, and a mean draft of 26 feet. The armor is 10 inches thick amidships, tapering to 6 inches forward and 4.7 inches abaft, while the turrets have 10-inch armor, and the conning tower 12-inch. The main armament consists of twelve 12-inch 47-caliber guns mounted in four triple barbettes on the middle line. The projectiles of these guns weigh 900 pounds. The secondary armament consists of twenty 4.7-inch 50-caliber guns and sixteen 3-inch. The ship will have five searchlights, and there will be, for the first time in the Italian navy, Bullivant torpedo nets. She will have four torpedo tubes, two forward and two aft. Her estimated speed is 21 knots; more is probable.

—*The Engineer*, December 16, 1910.

Italian Dreadnoughts.—It is reported that the Italian Admiralty contemplates the construction of four super-Dreadnoughts of 24,000 tons each as soon as the slips of the four Dreadnoughts which are now being built become free. The construction of the Italian vessels which are now on the slips will be pushed forward so that the first division will be finished by 1913 at the latest. One of them, the *Dante Aleghieri*, is already launched, so that the second division, therefore, may be expected to be completed by 1915. This proposed increase of the Italian navy has a double importance for Great

Britain, first as a possible opponent in the Mediterranean, because, after all, Italy belongs to the Triple Alliance on terms which never have been made public, and, secondly, because the Austrian shipbuilding programme will be influenced thereby, and every new Italian Dreadnought will ultimately be answered by another in Austria. The navy propaganda already demands that the Monarchy must also have eight Dreadnoughts by 1915.

—*The Engineer*, November 11, 1910.

Stowage of Battleship Boats.—The advantage of the center line, as evolved in America, is very apparent in this particular direction. American Dreadnoughts stow most of their boats under the gun level instead of over it. It is a curious fact that, although in nearly every ideal ship that has been proposed an armored shelter is provided for the boats, no ship in existence is so fitted.

—*The Engineer*, November 11, 1910.

The British Neptune.—The *Neptune* shares with the *Lord Nelson* class the distinction of having a peculiar "French" appearance. There is, of course, nothing in the French navy like the *Neptune* in the matter of gun arrangements, but the built-up superstructures and so forth show far more than the guns at a little distance. Whether all this top hamper is desirable is a vexed question. It certainly looks likely to tumble down and block the guns after the first shell or two.—*The Engineer*, November 11, 1910.

German Naval Items.—The *Standard* states that the Germans are making a 14-inch gun. It is added that inquiries establish the fact that the statement is correct, and that the gun has long been under consideration. "Never have the naval workshops of the Fatherland been so busy as at the present time, and the guns and reserve of guns available will shortly eclipse all other Powers. Krupps cannot work fast enough or employ men enough. The shipbuilding centers are crammed with work, and all engineers on the Admiralty list will be busy for years to come with the contracts in hand. The process of acceleration is permanent, with the result that Germany is the greatest arsenal in the world. In addition to naval guns, Germany is experimenting with a new automatic gun, a gun for dealing with airships, and a new rifle."—*Page's Weekly*, November 4, 1910.

The Next Dreadnought.—The first German Dreadnought of 1911 will be ready by the end of March. This is the *Ostfriesland*, now being completed at Wilhelmshaven. She has a displacement of 20,000 tons and will carry a crew of over 1,000. She was launched in September, 1909, and when finished will have cost between 36 and 40 million marks.

—*Hampshire Telegraph*, Jan. 6, 1911.

Naval Gunnery.—The Berlin correspondent of the *British Navy League*, who should have good sources of information, evidently thinks the shooting of the Teutonic fleet is very proficient. He writes:

"That gunnery has attained an advanced stage of excellence in the German High Seas Fleet is, I believe, admitted by all persons whose information renders them competent judges. Unfortunately, only at rare intervals are we furnished with chapter and verse for this assumption. I am able to state, however, that since the spring the Gunnery Lieutenants of six battleships and three cruisers attached to the fleet in question have been the recipients of unqualified notices of approval from the Marine Amt. in regard to their progress. A gunnery officer attached to the fleet remarked to the writer three weeks ago:—'I am neither able nor willing to give you details of our practice, but I can assure that our shooting is not even second to those wonderful achievements by certain of your own ships which have appeared in the papers of late.' And I have every reason to believe the truth of my informant's assertion."—*Hampshire Telegraph*, January 6, 1911.

Disposing Gun Turrets.—Reverting to the question of the twin and triple-gun turrets, dealt with in our last issue, it may be said that although the Italians and the Russians are the first to actually embody triple-gun turrets in the design of their mastodons, the Japanese and the Germans have, for some time, been discussing this method of arranging the primary armaments of their battleships. The American triple-gun turrets had one gun superimposed, but in the Italian and Russian plan all three guns are on the same plane. So far as theory is concerned, the question of broadside and axial fire is probably not best solved by a triple-gun turret arrangement, if the armament is to consist of twelve primary guns only. Twelve guns disposed in four turrets—two aft and two forward—would, if the guns of the second turret on the central line were made to fire over the forward and after turret respectively, give 50 per cent. of head and stern fire respectively, and a broadside fire of 100 per cent. But it has to be remembered that a single well-placed shot would put all the guns of one turret, or 25 per cent. of a ship's long-range guns, out of action at a single blow. This is a great risk to take in modern naval fighting, and one to be avoided as far as possible. On the other hand, gun fire is more easily concentrated and controlled by this system of mounting, and that is a point of great value. Tests and practical experience, however, will be the best guide, and we are prepared to trust British constructors in seeing that this country is not left behind in such an important point of warship design.—*United Service Gazette*, October 20, 1910.

British Dreadnought with 13.5-inch Guns.—Discussing the new 13.5-inch guns which are to be mounted on the latest British Dreadnoughts, the *Neue Frei Presse* (Vienna) considers that after their installation the warships will represent theoretically a greater fighting force than the Dreadnoughts of the other Powers. Consequently, Germany and other countries will sooner or later be compelled to follow Great Britain's example. The increase in the caliber of the British naval artillery involves Austria-Hungary in a serious plight. Either she must see her new Dreadnoughts outclassed by the British ships before they are even launched in the Adriatic, or, if she follows the example of other Powers, she must engage in a new and vast expenditure.
—*The Engineer*, November 18, 1910.

Fire Control Stations in German Ships.—It has long been rumored that the Germans were making experiments, to which a certain amount of success was attributed, with a system of observation for fire control purposes, intended to replace the elevated and exposed control positions which are now employed. Matters of this kind are necessarily confidential, and the statements which are made with regard to the new system appear to proceed on the lines of the most probable. If a concealed central station is to replace the elevated observing station, it is hardly possible to conceive how this can be accomplished otherwise than by reflection. The periscope of the submarine appears to be the type of such apparatus. The Germans are, perhaps, pre-eminent in optical science, and it is conceivable that they have attained results much in advance of anything yet achieved. Prismatic telescopes and fine adjustments may probably enable measurements to be made with extreme accuracy, and thus may permit fire to be controlled from below the water line. There must, of course, be elevated tubes for such appliances, and it is a question whether they will not be as liable to destruction as the existing stations. If they offer a lesser target, they will be much more frail, and perhaps liable to destruction by splinters. On the other hand, it may be possible to multiply such appliances, and the system may be applied even to the navigation of the ship. It is stated that the German new ships will have such appliances, in association with tubes on the sides of the ships, not much above the water line, giving a telescopic view of near objects.—*The Army and Navy Gazette*, Dec. 31, 1910.

Japanese Battleship to be Built at Barrow.—It is stated that Messrs. Vickers, Sons, and Maxim have just signed a contract for the building of a new *Dreadnought* battleship-cruiser. The new vessel will, when completed, have a displacement of between 27,000 and 28,000 tons, and is to cost about £2,500,000. It is stipulated in the contract that every portion of the warship, including hull, armor-plate, armament, gun-mountings, etc., is to be built in England by Messrs. Vickers, Sons, and Maxim, who are under obligation not to sublet any portion of the contract. It is said that the Imperial Japanese Government wish to mark their appreciaton of British workmanship in shipbuilding, and to give expression in practical form to the sincere feeling with which they regard the alliance between Great Britain and Japan. The extent of this feeling may be gauged from the fact that Japan has now five yards standing idle where she can herself build Dreadnoughts in every detail. The last Japanese warships built in England were completed in 1905. They were the *Katori*, built by Messrs. Vickers, and the *Kashima*, built by Messrs. Armstrong. Since then the following warships have all been built in Japan: Pre-Dreadnoughts:—*Tsukuba* and *Ikoma*, four 12-inch and twelve 6-inch guns; *Ibuki* and *Kurama*, four 12-inch and ten 8-inch guns. Dreadnoughts:—*Satsuma* and *Aki*, four 12-inch and twelve ten 10-inch guns; *Kowachi* and *Settsu*, twelve 12-inch guns.—*Page's Weekly*, November 25, 1910.

New French Torpedo.—*The Moniteur de la Flotte*, in an article advocate ing the use of a very high-speed but short-range torpedo for torpedo-vessels, gives the following particulars of the latest model French torpedo: Speed, 38 knots for 1000 meters, 33 knots for 2000 meters, 28 knots for 3000 meters; extreme range, 4000 meters; deviaton at 3000 meters, less than 30 meters; diameter, 45 cm.; charge, 108 kilograms; length and weight unchanged from previous model; cost, 13,500 francs, as against 12,000 francs for previous model.—*United States Naval Institute Proceedings*, December, 1910.

Gyroscope for Firing a Wayward Torpedo.—Lieut. Comdr. Cleland Davis, U.S.N., has invented a gyroscope for automatically firing a torpedo when it swerves too far from its course, which was patented on Oct. 4 through Messrs. Wilkinson, Fisher and Witherspoon. The invention, the specification states, while specially designed for use in torpedoes carrying a gun constructed according to the inventions heretofore patented by Commander Davis, may also be adapted to firing the high explosive charge of an ordinary automobile torpedo, such as the Whitehead or Bliss. It adds to the means for firing the torpedo gun by electricity independent means operated by a gyroscope for automatically firing the torpedo or the torpedo gun when the automobile torpedo swerves beyond a predetermined angle from its original course. "It is well known," the specification states, "even in ships acting singly, that a torpedo with a war head on is liable to return to the ship from which it was fired. This danger is largely increased when launching torpedoes in fleet formation. To protect against this I provide an arrangement operated by the action of a gyroscope, in which, when the torpedo swerves through a predetermined angle, say ninety degrees, from its original course, an electrical contact is made by said gyroscope, completing a circuit through an electric primer and firing the gun or torpedo. For this purpose a separate gyroscope may be used, but since all modern automobile torpedoes are provided with the Obry attachment, it will be more convenient to use the gyroscope already placed in the torpedo not only for the original purpose of steering the torpedo, but for the additional purpose of firing the same should the torpedo escape from the control of the steering mechanism governed by said gyroscope. When this gyroscope is doing its duty controlling the steering rudders it is not needed in the firing mechanism; but when, owing to the swerving of the torpedo from its original course it has outlived its usefulness in controlling the steering engine, then it still serves to fire the torpedo when this swerving becomes excessive.—*Army and Navy Journal*, Oct. 22, 1910.

Germany Has New Gun.—The *Vorwaerts* (Berlin) gives details of the successful application of the principle of the machine gun to rapid firing artillery. The experiments have been going on for years.

The difficulty of cooling the guns owing to the great heat generated by firing them for a long time baffled the designers. This has now been overcome by utilizing part of the force of each recoil to send a stream of water along the gun tube.

The new gun fires three times as rapidly as the ordinary rapid fire gun. The invention apparently is more suitable for stationary than field artillery. It is already in use in the German navy.—*New York Sun.*

Universal Projectiles.—For years past artillerists have been endeavoring to obtain a shell which shall be effective both as a common shell and a time shrapnel. The idea is to fill the spaces between the bullets with high explosive, which merely burns when the shell is burst in air, but detonates when started by a fulminate primer on impact. This sounds simple, but has not proved easy to carry out. In the shell tried by the French Government the high explosive, when burnt in air, melted the bullets. This difficulty was overcome by Messrs. Ehrhardt, who used trinitrotoluol as an explosive, and their shell was adopted by the German Government for the field howitzer. Messrs. Krupp have recently brought out a new universal shell, stated to be an improvement on all previous designs. The bullets are packed in three successive layers of different grades of high explosive, in the composition of which T.N.T. predominates, and the head contains two exploders, acting successively. When burst as a time shrapnel the flash travels direct from the fuse to the base burster; the bullets are blown out, and the head goes on and acts as a high-explosive shell on its own account. When the shell bursts on impact, it is stated that complete detonation of the whole of the explosive in the shell is obtained. If this is correct, the universal shell will be a valuable addition to field artillery armaments. We believe that our

Woolwich manufacturing departments have several times proposed to experiment with shell of this nature, but sanction has been refused by the War Office on the score of expense. Now that general attention has been attracted to this new projectile by its adoption in Germany, it is to be hoped that sounder views will prevail. Refusing to spend money on re-armament is frequently justifiable, since the problem of getting the best military value out of available funds is not an easy one. But refusing money for experiments is a penny-wise policy which invariably leads to increased expenditure in the end.

—*The Army and Navy Gazette*, December 17, 1910.

Fortifying Port of Salina Cruz.—Salvador Herrera y Cairo, lieutenant colonel of artillery, arrived in the city yesterday from Salina Cruz, where he has been in charge of the work or fortifying that port. Colonel Herrera y Cairo was sent for by the secretary of war to report upon the progress of the work at Salina Cruz and he made the following statement:

"The work is progressing with great rapidity and will soon be completed. Among the most important parts of the work is the construction of the railroad to the top of the Cerro de Buena Visa. This hill commands the approaches to the harbor and the valleys of Tehuantepec and Juchitan and will be a most important military road. It will be used to transport material for the mounting of the cannon to be installed on this height and afterwards as a means of supply. After this is completed, work on the road to the top of the Cerro de la Estrella will be pushed to a rapid conclusion and guns will be mounted there, thus making the port of Salina Cruz one or the strongest fortified ports on the American continent."—*Mexican Herald*, Oct. 27, 1910.

The Dutch Fortifications.—The question of the proposed Dutch fortifications is a burning one for Great Britain. It is said by the *Figaro* that the presentation to the States General of Holland of the Bill providing for a credit of forty million florins for fortifications will be accompanied by a secret treaty stipulating that Germany shall afford military assistance to Holland in the event of war exposing the forts at Flushing and elsewhere on the coast to attack by a third Power. M. Mares von Swinderen, the Dutch Minister for Foreign Affairs, has just said that the relations between Belgium and Holland are so good that it will soon be possible to cry "There is no longer a Schelt!" In such a case the Dutch are unlikely to bind themselves by secret treaty to Germany or any Power, in order to prevent assistance coming to Antwerp from England. The matter needs to be kept before the public, as it has an enormous military importance for this country. We are bound by treaty to send a fleet and an army to the assistance of Belgium if attacked either by France, Germany, or Holland. And as an attack by the Dutch is in the highest degree unlikely, Belgium and Britain are equally concerned in providing for a free passage up the Schelt to Antwerp, in case either the French or Germans attempt to take that powerful fortress.

—*Army and Navy Gazette*, December 10, 1910.

Copper versus Aluminum for Conductors.—It is interesting to study the rivalry between copper and aluminum as conductors of electric current. The conductivity of aluminum is but three-fifths of that of copper. On the other hand, it is so much lighter that, pound for pound, aluminum is a better conductor than copper. The cost of aluminum is slightly greater than that of copper, but not sufficiently greater to prevent it from being a cheaper conductor if bare wire is used; but when we come to insulated wire, copper has an advantage over aluminum, because in wires of the same conductivity the cross section of the copper would be less than the cross section of the aluminum conductor, and hence would require less insulation, due to its smaller diameter. This, however, holds only below certain sizes, for the conductivity depends upon the cross-sectional area, and the latter varies as the square of the diameter, so that in the end aluminum wins the race for the large insulated conductors.—*Scientific American*, December 24, 1910.

Brittleness of Tungsten Lamp Filament Overcome.—An ingenious scheme for overcoming the brittleness of the tungsten lamp filament when not burning has been devised by E. M. Fitz, the electrical engineer of the Pennsylvania Lines West of Pittsburg. This method consists in having a small current pass through the lamp when extinguished. On cars using 63 volts (32 cells), the two end cells of the battery, giving four volts, are connected to the lamps when extinguished. This keeps the filament at a faint dull red and makes it as strong as that of a carbon lamp. Recent tests show that the life of a tungsten lamp will vary from 1500 to 2000 hours when this system is used.—*Machinery*, November, 1910.

Economy Possible Due to Power Gas.—In a lecture delivered at Sir John Cass Technical Institute, J. S .S. Brame pointed out that the introduction of power gas has made possible considerable economy in the use of natural fuel resources. Apart from the use of blast-furnace and coke-oven gas, previously wasted, the replacement of steam power by gas power would diminish the annual consumption of coal for power in this country by 9 million tons, or about 20 per cent. Power gas can also be generated from peat and other poor fuels not suitable for raising steam. There are 140 million acres of peat bog in Europe. For small powers, up to 30 brake horse-power, the author recommends the use of coal-gas rather than a gas plant; from 30 to 250 brake horse-power a suction gas plant is recommended; and for greater power, a pressure gas plant. The success of the suction gas plant using bituminous fuel is now established. Recent developments are the use of the engine exhaust in place of steam in the producer, and, in Germany the abolition of the gas holder in pressure gas plants, the production being controlled by fans driven by the engine.

—*Scientific American Supplement*, December 10, 1910.

Nothing Alcoholic on Canadian Ships.—"Ex-Attache," in the *New York Tribune*, says: "Canada has taken to heart the Kaiser's recent homily on the importance of sobriety in the naval profession, for it has been announced that alcohol in any form or shape is strictly forbidden on board the cruisers and gunboats of her new navy. Emperor William wound up the address referred to above, and which was delivered at the dedication of the new naval academy at Flensburg, with the words, 'Victory in the next war will crown the colors of the nation which consumes the least alcohol.' This does not mean that William is a total abstainer. He drinks both beer and wine in moderation, as all those Americans who have been entertained by him at the yacht races at Kiel, on the Hohenzollern, at Berlin, Potsdam or Wilhelmshohe can testify."

—*Army and Navy Journal*, December 24, 1910.

CORRESPONDENCE

Any communication received by the Editor, which the writer desires inserted, which is signed by him and which would be of interest to the readers of the JOURNAL from a military point of view, will be published in this department. It is especially desired to have questions asked and small items of information given. Questions asked in one issue will be answered in the next, where possible ,by some person, or persons, who is considered to be capable of giving authoritative information on the subject involved. Answers or remarks, regarding any such question by any others will always be very welcome. The readers of the JOURNAL (and all others interested in it or its work) are most cordially invited to make full use of this department.

PROBABLE ERROR OF GUNS IN FIGURE OF MERIT

Columbus Barracks, Ohio,
December 28, 1910.

The Editor, Journal U. S. Artillery,
Fort Monroe, Va.

Sir:

As Coast Artillery Memorandum, No. 6, 1909, requires all battery commanders to submit Probable Error Cards, showing "Expectancy of Hits" as a basis, to determine the probable error of guns, and to have a measure of accuracy of the battery, it would seem, that said factor should be taken into account in determining the rating of the company using said battery at a practice.

To determine the figure of merit we have according to Coast Artillery Memorandum, No. 1, 1910, for guns, the following:

$M = CH \div P$, where "C" is a factor based on relative times of loading for various calibers and various mounts and given a definite value according to the gun and mount. "H" is hits per gun per minute and "P" is probability of hitting.

In this formula, it is assumed that two batteries of same mount and same guns have the same chance or same expectancy of hits which to me does not seem necessarily true. If both guns are in the same condition as to wear, identical mount and identical action of mount, it might be so.

As a concrete example, we may take battery Eustis mentioned by Captain Hamilton* using the ordinary banded projectile, showed one gun giving from date an expectancy of hits of 61.7%, or six hits out of ten. In other words, the best that could be required of the personnel was the six hits out of ten shots.

Suppose another battery to have an expectancy of hits of 100%. If, in a given practice, each of these batteries made 6 hits, under circumstances such that CH and P were the same, their ratings would be the same. We know, however, that the personnel in the first case did the best they could be expected to do, while the personnel in the second case only made six hits, when they should have made ten; yet the standing of the two companies will be the same.

---

* See page 291, Vol. 32, Journal U. S. Artillery.

It seems that we ought to have an additional factor in the expression for the figure of merit, based on the expectancy of hits in that particular battery. If we call this factor E, our expression for M would be $M = CH \div PE$ or $M = \frac{CH}{PE}$.

To determine equitably the value of "E" would be the problem. This factor should be based on the accuracy of the battery and could be taken from the data of the trial shots. A probable error card might be calculated from the trial shots of the previous season, taking all trial shots fired at the battery during the preceding year, and this error factor be used as a value of "E" in the succeeding season only; then the next year, the new data of the year be taken.

It is thought that since the relative standing of companies at target practice is published some account should be taken of the relative accuracies of the batteries concerned, so as to arrive at a true figure of relative value of personnel.

Very respectfully,
W. J. Buttgenbach,
1st Lieut., Coast Artillery Corps.

THE COMPOSITE ARTILLERY TYPE TELEPHONE

Fort Andrews, Mass.,
January 3, 1911.

The Editor, Journal U. S. Artillery,
Fort Monroe, Va.

Sir:

In reading the article entitled "Composite Artillery Type Telephone" published in the November-December issue of the JOURNAL, I was impressed with a statement made therein which, although doubtless not so intended, may readily convey a false impression. I refer to the second paragraph on page 270 as follows:—"Since the currents in the primary circuits of the distant telephones vary in unison with that of the home telephone, a secondary current will be induced in each distant telephone similar to that in the home instrument."

Considering the home and distant telephones as each a branch of a divided circuit, supplied with current from the common battery through the retardation coils, it is evident that a decreased resistance in the home transmitter will result in an increased flow of current through the home branch of the circuit. At the same time, the resistance of the distant transmitter remaining unchanged, the current in the distant branch will decrease owing to the lowered resistance of the home branch of the circuit and the action of the retardation coils in choking down any growth of current from the battery. Then although the currents in the primary circuits vary "in unison," so far as time is concerned, they actually vary inversely so far as their strength is concerned; *i.e.* while the current in the primary circuit of the home telephone is increasing, the current in the primary circuit of the distant telephone is decreasing at exactly the same rate, and *vice versa*. Still, the growing current in the S winding of the home induction coil, induces exactly the same current, except as to direction, in the T winding of its coil as the failing current in the S winding of the distant induction coil induces in the T winding. Since the direction of the induced current affects only the direction of vibration of the receiver diaphram and not the sound produced by it, the sound produced in both receivers is identical. This action of two currents of different characteristics producing the same sound is one of the most interesting phenomena of telephony.

Very respectfully,
Louis B. Bender,
2nd Lieut., Coast Artillery Corps.

AMENDMENTS TO REMINDER LISTS

Fort H. G. Wright, N.Y., January 9, 1911.

The Editor, Journal U. S. Artillery,
Fort Monroe, Va.

Sir:—

I wish to invite, through your correspondence columns, suggestions from officers of the Corps, that will be of use to me in amending Reminder Lists for Service Practice published last year. I shall greatly appreciate any hints that may be furnished, and request that same be mailed to me at an early date to the above address.

Very Respectfully,
W. E. Ellis,
Major, Coast Artillery Corps.

F. C. SYSTEM TESTS SHOWN GRAPHICALLY

Fort Worden, Washington, January 10, 1911.

The Editor, Journal U. S Artillery,
Fort Monroe, Va.

Sir:

I am enclosing herewith a print which I think shows the advantages of the graphic method of keeping the data of the maintenance tests in the Fire Control System.

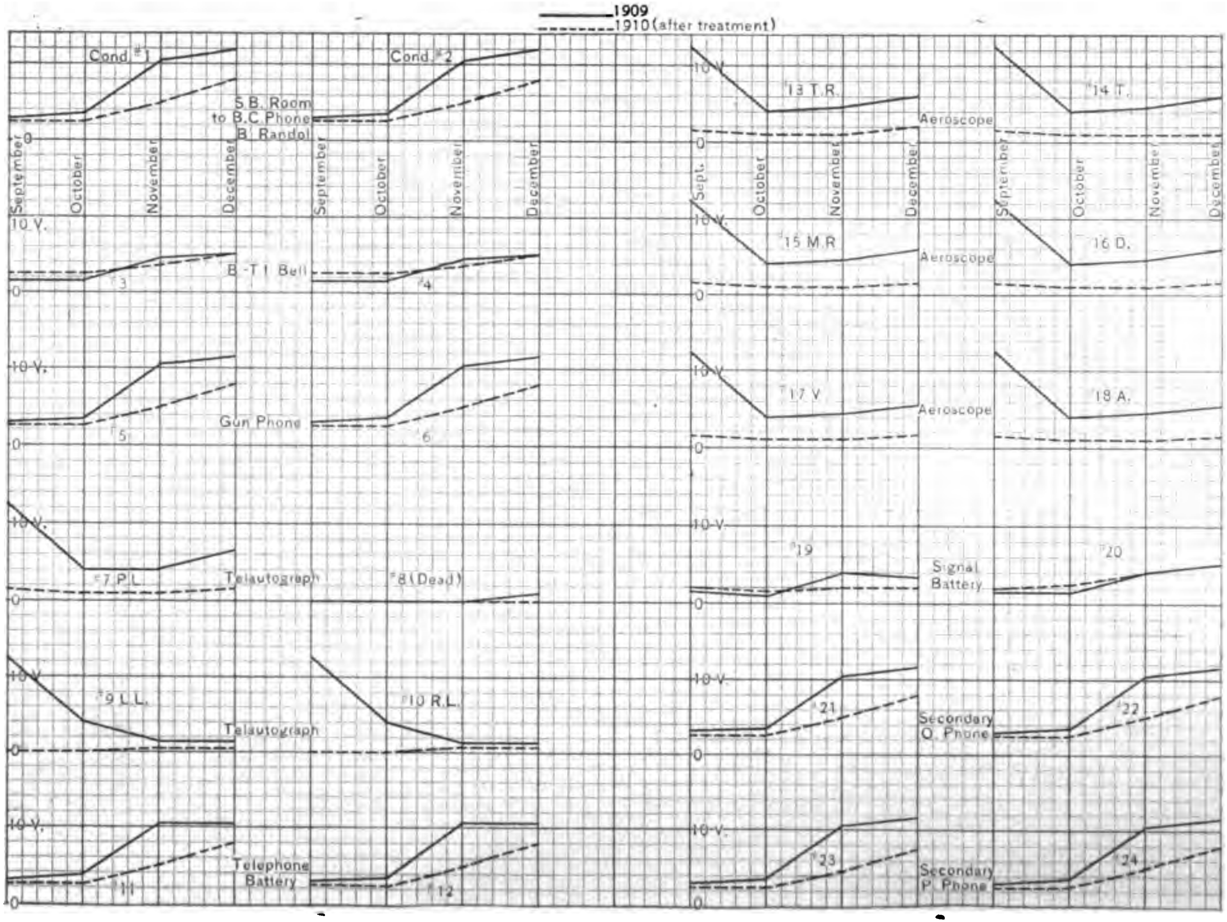
Of course graphical methods are almost always advantageous, but when such a mass of figures as the test of a large fire control system comes in at the end of the month, I certainly think that a clearer and quicker view can be had of the condition of the system and faults more readily discovered, if the figures are plotted at once.

As shown, the curve is made continuous for a year and the new year started over the same ground, with all effort made to make it keep below the preceding record.

These particular curves are extracts from tests during the wet season showing the results of treating the station wiring with a preservative and insulating compound.

Very respectfully,
E. Canfield, jr.,
Captain, Coast Artillery Corps.

CURVES SHOWING VOLTAGE TO GROUND ON THE VARIOUS CIRCUITS OF BATTERY RANDOL FOR THE MONTHS OF SEPTEMBER, OCTOBER, NOVEMBER AND DECEMBER, 1909 AND 1910



NIGHT SHORE SIGNALS TO TUG

Fort Moultrie, South Carolina,
January 3, 1911.

The Editor, Journal U. S. Artillery,
Fort Monroe, Va.

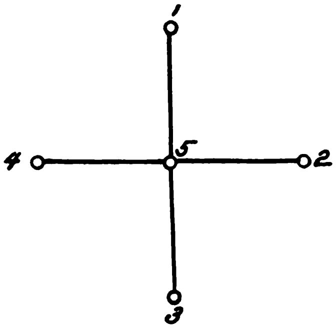
Sir:

The following may be of interest to any one desiring to provide means of signalling the tug from shore at night drill or night practice.

NIGHT SHORE SIGNALS TO TUGS

Place a cross arm twenty (20) feet long on a shore signal mast and place five (5) white incandescent lights, with reflectors arranged to project light towards tug, as follows:

One at intersection of mast and cross arm; one at each end of cross arm; one ten (10) feet above and one ten (10) feet below intersection on mast; numbered, top 1, right 2, bottom 3, left 4, center 5.



The following combinations are possible:

1254–1235–2345–1534–1234–12345–153–452–123–234–143–412–12–14–42 and 13. A single light is apt to be confused with some other shore light, and should not be used.

The ordinary night signals make use of colored lights, but so much of the light is lost, especially with red, that the signals are not distinguishable at as great a distance as a combination of all white lights.

The device for this system is easily constructed on the ordinary signal masts used for day signals at artillery posts, and a plug-in board arranged, numbered as above so the plugs can be inserted for any given signal and the power switch thrown so as to give the completed signal at once.

This system is in use at Fort Moultrie, S. C. The various signals being given numbers and meanings similar to system devised by Major Ellis.

To signal the tug, all search lights are removed from tug and from across line of sight to tug. This warns tug detail to look out for signal. The signal desired is then made, and is acknowledged as in "Ellis system" of day signals.

Very respectfully,
R. L. Carmichael,
Captain, Coast Artillery Corps.

BOOK REVIEWS

Military Topography for the Mobile Forces. By Captain C. O. Sherrill, U. S. Army. Sales Agents: U. S. Cavalry Association, Fort Leavenworth, Kansas, and U. S. Infantry Association, Washington, D. C. 5¾ x 8¾. xviii + 356 pages. 154 il. 1 pocket map. 1910. Price, $2.50.

The popularity enjoyed by "Military Map Reading" published in 1909 by Captain C. O. Sherrill, C.E., U. S. Army, of which 10,000 copies were sold, bids fair to be exceeded by "Military Topography for the Mobile Forces" by the same author. Captain Sherrill's position as instructor at the U. S. Service Schools, Fort Leavenworth, Kan., and the adoption of his latest book as a text-book therein is a sufficient guaranty of the value of the work. Its special features recommend it to the officer, be he of the regular or auxiliary forces, desiring information upon the subjects treated.

It is too often the fact that the ordinary text-book requires an instructor for its elucidation. In this respect Captain Sherrill's work is unique. Its object, as stated in its preface, is "especially to assist officers in acquiring that trained topographical eye which grasps instantly the possibilities and limitations of the terrain in its influence on the military situation" and the treatment is of the utmost simplicity.

The book is in three parts,

I. Military Map Reading;
II. Military Surveying;
III. Military Sketching.

The first is a revision and amplification of Captain Sherrill's earlier work. It deals with means used for determining horizontal distances, methods of representation of differences of elevation, of slopes, directions on maps and visibility, with numerous examples and problems under each head.

A sub-head "Maps used for War Games and Tactical Problems" contains scales of movements of military units and information concerning such maps which, because of the fact that more attention is to be given in our service to these methods of military instruction, is just now of general interest.

The necessity for exactness as a guide and check on estimates of ground forms and a grasp and comprehension of ground is insisted upon, hence Part II. gives the means necessary for comparing angles and distances in making required measurements, the plane table and stadia methods, as the best for acquiring skill in accurately estimating distances, slopes and elevations, being given special prominence.

Separate chapters deal with the various instruments used and their adjustment, scales and verniers, selection of scales, vertical angles, contour surveying and map reproduction.

Much concerning military topography and the instruments of precision used in topographical surveying necessarily trespass upon other works treating of the subject but the author's extreme modesty in so carefully giving credit where due is not always so noticeable in like cases.

The secret of success of certain text-books, notably those of the various correspondence schools, is by many deemed to be that they deal with the subject treated from the standpoint of the student who has no knowledge whatever of the matter to which he is introduced. With this in mind a reason is apparently found for illustrating in this work an "original package" of "Kohinoor" lead pencils, a bottle of drawing ink and a rubber and a knife eraser and for representing and describing the necessary, but elusive, thumb-tack.

Military Sketching, containing in detail the method found at the Army Service Schools at Fort Leavenworth from long experience to be the best for instruction purposes, has many valuable hints and is of the greatest importance and interest.

Topographical reconnaissance reports are given a chapter of their own with a simple and effective typographical scheme whereby are separated so as to be seen at a glance, the items usually found in the report, from those shown in the sketch.

The use of the many problems to illustrate the work step by step is of especial benefit to those attempting a mastery of it without the guidance of an instructor.

The book of 365 pages with 145 figures and several tables for use in computations, besides an excellent loose map of Fort Leavenworth and vicinity, is from the press of the George Banta Publishing Company, Menasha, Wis., and is in large, clear type and of most creditable appearance. The usual separation of plates from their descriptive matter is noted in some cases, but these cases are unusually few. Typographical errors are almost eliminated. The index—but then, what index is perfect?

Cavalry Tactics as Illustrated by the War of the Rebellion Together with Many Interesting Facts Important for Cavalry to Know. By Captain A. Gray, 14th U. S. Cavalry. Fort Leavenworth, Kansas: U. S. Cavalry Associaton. 6″ x 9″. 13 + 187 pp. 1910. Price: Cloth, $1.50; paper, $1.25.

This unique and most interesting volume has recently been issued by the U. S. Cavalry Association and should be in the library of every mounted officer,—we might better say, in the hands of every student of field service.

The book is not a continuous narrative, but is made up of extracts and quotations from the Rebellion records, histories, memoirs of commanders and personal narratives, the object being to show what cavalry did in that great struggle, how it was done, when and where.

The author's peculiar method of continuous extract, with indicative marginal notes, makes it easy for the student to find just what he is looking for, backed up by the terse statement of the authority.

There has been much discussion in recent years, as to the comparative value of saber and pistol. The exponents of each weapon will find in Captain Gray's volume practically all the *facts* that the Rebellion brought out as to the use of both arms—and they are legion. To us, this chapter is intensely interesting, while his "summing up" of the evidence would do credit to the canniest of judges. "There has been a great deal of discussion in the U. S. Cavalry Service in years past regarding the relative merits of the revolver and saber. Such discussion is time wasted. *Each weapon has its distinct and proper uses* and neither can replace the other; *nor can either of them be discontinued as a necessary part of modern cavalry armament.*"

If you want to know what our cavalry has done in the past, where and when and how they did it, and what *good* cavalry will do in the future, read this book.

Strong Vincent and His Brigade at Gettysburg, July 2, 1863. By Oliver W. Norton, Private 83rd Regiment Pa. Volunteers. Published in Chicago. 6 x 9. 58 pages. 1 il. and frontispiece. 1909.

Any reliable recollections or data which can contribute to a more accurate history of the Battle of Gettysburg, ought to be published and carefully preserved, especially regarding the great crises of that important battle.

Mr. Oliver W. Norton, while acting as Brigade bugler and bearer of the Brigade headquarter's flag, overheard an important conversation and witnessed the execution of an order, resulting from that same conversation, which placed Colonel Strong Vincent's Brigade in command of Little Round Top, which he relates in this small volume.

And as Colonel Vincent had assumed all responsibility in taking possession of that strategic point, and as this monograph by Mr. Oliver Norton seems to prove the verity of this gallant action by Colonel Vincent, it assumes interest as a valuable addition to the military history of the critical battle of the Civil War; and while not tending in any way to belittle the remarkable sagacity of General G. K. Warren in discovering Little Round Top as the salient point of the Southern attack, it, however, gives full credit to the daring and valient execution of Colonel Vincent in instantly occupying and holding the crux of the situation against tremendous odds, entirely on his self-assumed responsibility as a Brigade Commander.

The book relates how this gallant decision was further glorified by his heroic death, and that it has established for all times his military wisdom in securing a militant victory, which stemmed the tide of Southern success, and decided a battle which proved to be the turning point in the greatest War of modern times.

Extracts from the contemporaneous reports of all the prominent generals engaged in the action, and further comments by able officers on both sides of the battle are included in this volume by Mr. Norton, and tend to prove the accuracy of the version and substantiate the conclusions of the Author.

The book carries conviction with its account, and adds another page to the records of the Civil War from an entirely different point of view.

If, perchance, we take issue with Mr. Norton's conclusions as here reviewed, still let us take the book and read it, for it reveals another version of the remarkable bravery and sacrifice of Colonel Strong Vincent, who was, however, but one of the illustrious and innumerable throng of gallant heroes of that time, who gave their all, and gave it gladly, on both sides of the deadly controversy, and who by their wisdom and sacrifice have welded our land into a more perfect unity of freedom, love, and power.

A Manual for Aspirants for Commission in the United States Service. By Captain Ira L. Reeves, U. S. Army. Kansas City, Missouri: Franklin Hudson Publishing Company. 4½" x 7". ix + 219 pp. 1910.

In a well bound little volume of 219 pages, entitled "A Manual for Aspirants for Commission in the United States Service," Capt. Ira L. Reeves, U. S. Army, (Retired), has compiled and originated a fund of useful information for the ambitious young American seeking a Commission in his country's military service. The ground is fully covered from how to obtain a Cadetship at West Point, to how to be third Lieutenant in the Philippine Constabulary. Much time will be saved by the young man seeking a commission if he will consult this little book and besides he will receive information that can be given only by one who has had long experience with soldiers and in military affairs. This may mean the difference between a wrong and a right start, which is all-important.

NOTICES

DISTRICT ROSTER OF TROOPS

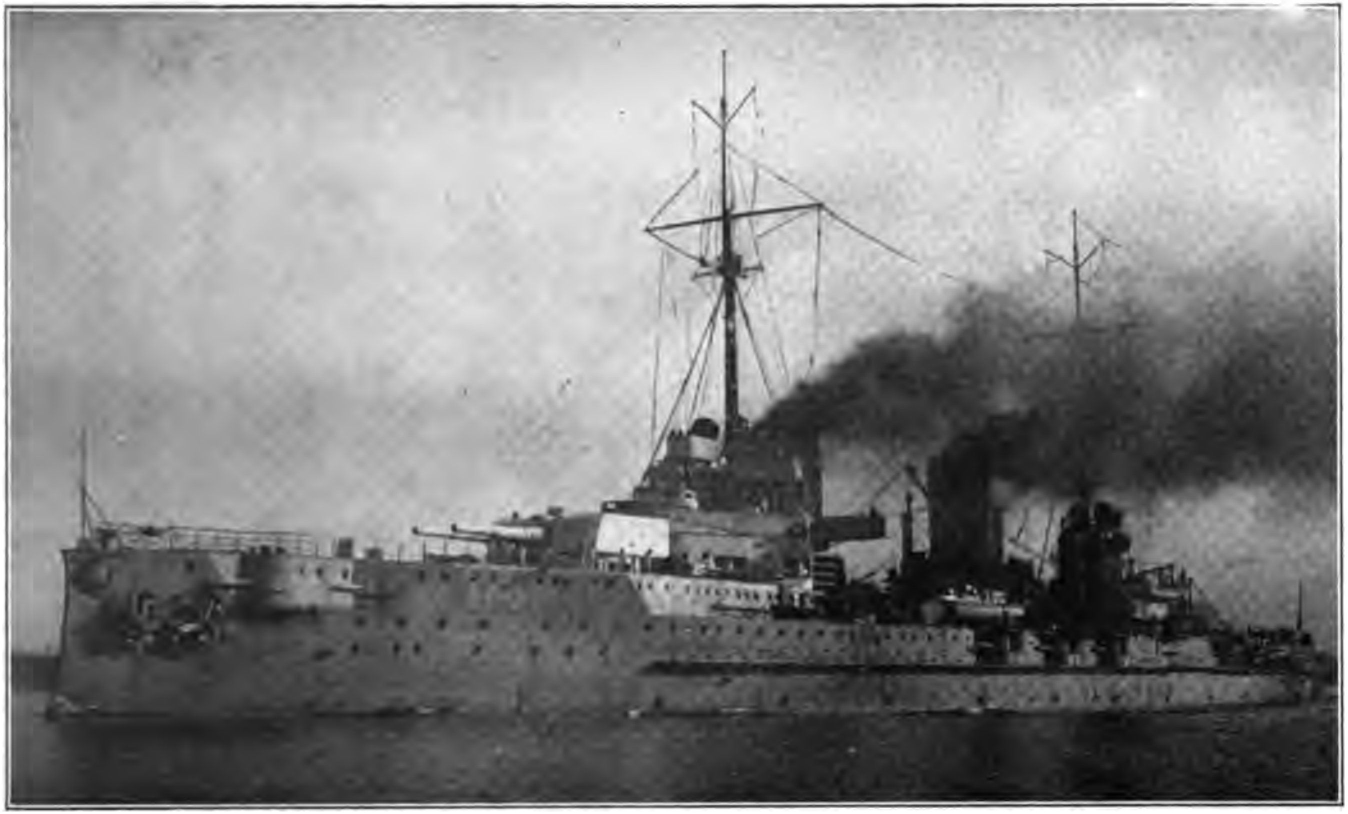
We acknowledge, with thanks, receipt of a copy of a "Roster of Troops serving in the Artillery District of New London, commanded by Lieut.-Col. William C. Rafferty, C.A.C." The information is of date January 15, 1910, and was compiled by Capt. H. S. Kerrick, C.A.C., then Adjutant of the New London district.

Such a roster for each district in the Coast Artillery would be most useful. It contains the list of the district commander and staff, with date of arrival in the district and date of detail on present duty.

For each post are given all particulars as to location, transportation lines reaching it, etc.; list of officers and for each company the name of each of its enlisted members with date of enlistment, present duty (if any other than ordinary), whether a gunner, or occupying other rated position.

A small map of the district shows the relative locations of the various posts, distances between them and to nearby places.

The idea of this roster is excellent and we should think every district would find a similar one of the greatest use.



Photograph by Carl Speck, Kiel.

H. M. TURBINE-CRUISER "VON DER TANN"

Maximum speed, 28.124 knots; mean speed, 27.4 knots. Length, 558 feet. Beam, 85 feet. Draft, 27.5 feet, Displacement, 19,000 tons. Designed H. P. at 25 knots, 45,000. Boilers, 18. Coal capacity, 2,800 tons. Armament: 8, 28-cm. guns in 4 double turrets; 10, 15-cm. guns; 16, 8.8 cm.

JOURNAL
OF THE
UNITED STATES ARTILLERY

"*La guerre est un métier pour les ignorans
et une Science pour les habiles gens.*"

VOL. 35 No. 2 MARCH–APRIL, 1911 WHOLE No. 108

MORE ON THE SELECTION AND DEFENSE OF NAVAL BASES

BY "AMPHIBIOUS"

How often in the course of reading and conversation do we meet the man who, finding that some particular feature of some subject is in need of reform, gets so enthusiastic thereon that he gradually deludes himself into thinking that that particular branch of his subject is the one and only feature that deserves any consideration, or if he does not actually think so, his arguments tend to create that impression in the minds of others. In the excellent article by "Colonel Martin, an ex-Confederate Officer," which appeared under the above heading in the last issue of the JOURNAL, the selection of a naval base is made to depend solely on the question of its defense from the land-side. The writer of this article admits that that feature has frequently received too little consideration, but that does not justify one in ignoring, or belittling, everything else.

In the defense of a naval base, all branches of the military services meet. It is the one common ground where the navy, the coast artillery, and the mobile army are mutually dependent, and the selection of the base and the dispositions for its defense, should be such as to give a maximum *general* efficiency, not a maximum in any one line to the detriment of others.

The base itself is a distinctly naval unit, the reasons for its existence are so admirably stated by Col. Martin, that there is no object in again going over that ground. It is simply desired to emphasize that the base exists solely for the navy, for the repair and refitting of naval vessels, and therefore that the first requirement in the selection of a base is that it should be properly adaptable to the needs of the navy, otherwise it has no *raison d'être.* The defense of the base is a function of the army, and comprises both land and sea fronts, thus bringing in the mobile army and the coast artillery.

Neither one of these elements can be subordinated to the others; if the base does not meet naval requirements, there is no virtue in making it impregnable by the army; again, if it can not be properly protected from the sea, what is the object in having an unassailable land front? And, finally, an efficient land defense is necessary no matter how secure may be the position from the sea. It is of course true that the navy affords a defense for its own base by obtaining control of the sea, or, strategically, as a fleet in being, but it does not do this by anchoring behind the guns of the fortifications, or even by maneuvering in the vicinity. Nelson's saying, "I consider the best defense for his Sicilian Majesty's dominions is to place myself alongside the French,"* illustrates the true *rôle* of the navy in coast defense, and in no way affects the location of the base, or the fact that the immediate tactical defense lies with the army. This feature also is fully treated by Col. Martin, and will not be further discussed.

Col. Martin shows that from the land defense side the most suitable site for a base is on a small island, and the least favorable on the bay of a continent, or large island, and that the further it is retired the more difficult it will be to defend.

Now what is the ideal from the sea front? Col. Martin lays down in his conclusion as an indespensable requirement for the base that "its own inherent strength and susceptibility for defense shall be such that a relatively small garrison may render it impregnable by land and sea." Webster defines impregnable as "not to be stormed, or taken by assault, unconquerable." But that is not sufficient. The object of the coast artillery defense is to protect the base from the enemy's fleet, not merely from capture, but also from damage. The same remark, of course, also applies to the land side, but a suitable defense against capture from that side will also defend against damage, for it is obvious that if the army of the enemy reaches a position where it can shell the base itself, the capture of the place is not far distant. The same, however, does not hold on the sea front, as the enemy could bombard the base without any idea of attempting its capture or of running by the fortifications. It is as much the duty of the coast artillery to prevent such a bombardment, as it is to prevent a capture, for the base must remain intact, if it is to be of any use to our fleet. If an attack is made, it is not sufficient that we have driven the enemy away and perhaps sunk one or two of his vessels. If his shells have succeeded in destroying, or materially damaging, the drydock, machine shops, coaling station, store-houses, etc., of the naval base, the defense has not fulfilled its purpose, and the base might as well have been captured for all the use it will be to our fleet. This brings up our primary requirement that the base exists solely for the benefit of the navy. The tactics of the defense must therefore be such as to keep the enemy at such a distance that it cannot harm the base in any manner.

---

* Mahan's Life of Nelson, p. 365.

It is universally conceded that ships will engage coast fortifications only under exceptional circumstances. But if a fleet could inflict material injury to a naval base,—particularly if the latter is a very important one,—without coming under a destructive fire, what naval commander would hesitate? To establish a naval base in such a situation would simply be an invitation to the enemy to destroy it from the sea.

The character of the targets of the attack and defense is important. The enemy's vessels can fire on a dockyard at the extreme ranges permitted by their gun mountings, this may be taken at 15,000 to 20,000 yards and their object would be to hit any element of the base with high explosive shells. The striking energy is of no importance, all that is needed is for the shell to reach its object and explode. The target is large and vulnerable. Many shots of course will be wasted, as accuracy of fire at such long ranges cannot be expected, but it will not need many hits to cause great damage, and if it is possible to land an observing party to signal results to the fleet, it would not take very long to destroy the utility of the naval base and the object of the attack would be achieved. On the other hand, the defense is firing at armored ships and striking energy is of vital importance. It is much more difficult to damage a battleship, than it is a drydock, or a machine shop. Therefore, if the ranges are equal, or in other words, if the base and the guns of the defense are the same distance from the fleet, our guns must so overmatch his that we can inflict injury on his ships at ranges beyond his maximum, *i.e.* over 20,000 yards. This is manifestly impossible. Should such improvements in ordnance be made, navies would themselves take advantage of it. It may be objected that guns, only, are considered in the defense, that mines, obstructions, and submarines have their part. This is true, but since fortifications are naturally advanced as far to the front as possible, an enemy at extreme ranges would be in the open sea, where mines and obstructions would not be practicable. The utility of submarines is yet to be tested. It would not do to rely on them at the present time. They may solve the problem, but they cannot be considered as more than adjuncts, until they have been proven otherwise. Therefore, it is to gun-fire that we must look to prevent bombardments, mortars being of course included in the general term, gun. Failing such an overpowering type of ordnance, it is necessary that the fortifications be advanced well in front, at such a distance that the base is out of range of the fleet, while the latter is under a destructive fire. This, therefore, points to a bay in a continent, or large island, as the ideal position and a small island as the worst location judged from the sea front defense. This is diametrically opposed to the land defense requirement, and a compromise must be made somewhere, as is the case in nearly all practical problems. An island where the base could be completely sheltered from hostile fire by intervening hills, or a bay where the land defense would be aided by natural obstacles, such as impassable morasses, etc., would be ideal from both standpoints. Too much value, however, must not be placed on the protection afforded by hills, as at such long ranges the angle of fall approaches 25° with a slope of fall of about 1 on 2, and the protected area would be very limited. Ideal situations are hard to find, so the question arises as to where and how compromises can be made; if the coast artillery demands one thing and the mobile army requires exactly the opposite, where can the maximum general efficiency be found?

There is no question but that the location must be suitable from the standpoint of the navy, otherwise it will be unnecessary under any circumstances; also it must be capable of protection from naval fire. Each of these is a *sine qua non.* As to its capture from the land, let a quotation given by Col. Martin be again made. "A nation's war policy is badly at fault, and its outlook when war begins will be gloomy indeed, if its naval stations cannot hold out *for a reasonable time* without assistance from the fleet." The italics are the present writer's. Is it necessary to make the base impregnable? If it can be done without sacrificing other advantages, so much the better of course, but *for a reasonable time* covers the real necessities of the case.

Col. Martin lays great stress on the admirable defensive situation of Gibraltar and cites the historic cases where it withstood protracted sieges, notably one for three and a half years, between 1779 and 1782. It is difficult to conceive of a case where such a length of time would be necessary in these days. Since the Napoleonic wars, no war has lasted for that length of time, except our own Civil War and it is universally conceded that civil wars are in general the most stubbornly contested and are the most likely to be protracted. Any naval base that we might establish would not be for a civil, but a foreign, war. Events move more rapidly now, than they did even fifty years ago, and the end is not yet in sight. Wars must of necessity become shorter and shorter, as science progresses.

In these days of 21-knot battleships and wireless telegraphy, Nelson's hunt for Napoleon in the Mediterranean, which lasted nearly three months, terminating in the battle of the Nile, would be an impossibility, and his chase of Villeneuve across the Atlantic and back, would certainly have been concluded in the West Indies, if not earlier. We should look to present conditions to determine what a *reasonable time* may be.

Any position can be held for a certain length of time and its inherent natural strength can be artificially increased by the construction of land batteries and communicating roads. Arrangements can be made for the coast batteries to assist on the land side, clearings can be made, and a complete plan of defense evolved. In considering the land defense question such features are frequently ignored; they should not be, however; the subject should be treated, not from the standpoint of its natural, but of its potential strength. If any site is then found not to be defensible for the necessary length of time, it is of course not suitable for the base.

As a practical illustration, consider the question of a Philippine naval base. Cavite is impossible from the navy view point, as battleships cannot get within miles of the shore and docks. At Corregidor, a secure anchorage could be formed by the construction of a breakwater and there is sufficient area for the necessary shops, etc., of the base, but they would be practically on a line with the gun defense and open to fire from the sea, therefore untenable in the event of naval bombardment. Subic Bay is admirably adapted both to naval and coast artillery demands, but is vulnerable to land attacks, so the question arises as to how long it would be necessary to hold it. Let Col. Martin be again quoted, "a fleet at any of these places (Honolulu, San

Francisco, or New York) could probably afford an effective, strategic defense to the Philippine Islands, if we had a well stocked, well equipped, and above all, a well garrisoned naval base awaiting its arrival in Far Eastern waters." He has answered the question himself. What need would there be to hold it for a longer period?—provided, of course, that we continue the traditional Anglo-Saxon naval policy of keeping our fleet together in one strong body, instead of dividing it into fragments to be beaten in detail. And provided, also, that our fleet would endeavor to "put itself alongside the enemy." Is Subic Bay capable of such a defense? If not, we should look to some entirely different place from those usually considered. But if it can be held for that length of time, why complain because it cannot be made impregnable?

There is perhaps no military subject which requires a broader treatment than this very subject of the selection and defense of naval bases, and the proposed National Defense Council would justify its existence ten times over, if it did no more than to bring order out of chaos in this one subject, by uniting the minds of competent statesmen and army and navy officers in reconciling the conflicting "requirements" made by each branch of the service.

In conclusion, a few words regarding Gibraltar, which at first sight appears to be a practical example of a successful base open to the sea and retired but little behind the fortifications. In the *Proceedings of the U. S. Naval Institute,* Nos. 113 and 114, will be found, under "Professional Notes," memoranda of the First Lord of the Admiralty regarding the distribution of the British fleet. It will there be seen that the Atlantic fleet is based on Gibraltar *in times of peace,* but in war on home ports and Gibraltar then reverts to the Mediterranean fleet, which has Malta as its principal base. The Malta yard is well to the rear on a bay. Apparently, the British Admiralty does not place any reliance on the use of Gibraltar as a naval base during war, notwithstanding its impregnability. In the days of smooth bores and black powder, the height of the guns gave the artillery defense at Gibraltar a very distinct advantage in range and destructive effect, but the increase in the power of ordnance has practically nullified it, and the relations between the attack and defense are by no means as they were before the introduction of rifled cannon. Historical examples showing the merits of Gibraltar as a naval base are worthless in the light of the present ordnance.

INVESTIGATION OF GASOLENE ENGINES WITH A VIEW TO DETERMINING THEIR SUITABILITY AS A SOURCE OF POWER FOR COAST DEFENSE INSTALLATIONS

By Captains JOHN O. STEGER and FRANK T. HINES, C. A. C.

Approved Solution, Advanced Course, Department of Engineering and Mine Defense, Coast Artillery School

(Continued from Jan.-Feb., 1911, Journal.)

Data and Results of Standard Heat and Efficiency Test of 25 K. W. Direct Connected Gas Motor Set, Arranged According to the Short Form* Advised by the Engine Test Committee, American Society of Mechanical Engineers. Code of 1902.

(*Made during first few hours work on problem. For more accurate regulation see page* 149.)

1. Made by *Captains J. O. Steger and F. T. Hines of Coast Artillery School,* on engine located *in laboratory of Coast Artillery School, Fort Monroe, Virginia,* to determine:
   a. *Whether the set can fulfill its contract guarantees.*
   b. *The full load and 25% overload efficiency of the set.*
   c. *The cost of electrical energy at the switchboard.*
   d. *Whether the set is adapted for service use with a statement of installations for which it is suited.*
   e. *Determine heat balances and electrical losses.*
2. Date of trial: *September 22, 1910.*
3. Type and class of engine: *Gas Motor No. 5496-Type G. M.-12-Form A-2. H. P. 43-54. Speed: 560 R. P. M. Four stroke cycle, gasolene fuel. Made by The General Electric Company, Schenectady, N. Y. (For information regarding generator and fan motor, see "Data Sheet".)*
4. Kind of fuel used: *Gasolene, specific gravity, .727 (Baumé 62.5) at 70 degrees Fahr.*
5. Dimensions of engine:
   a. Class of cylinder (working, or for compressing the charge): *Working and compression.*

---

* Items in the form are in roman, data from the problem in italics.

b. Single or double acting: *Single.*

c. Cylinder dimensions:

Bore . . . . . *6½ inches.*
Stroke . . . . *6¾ inches.*

d. Average compression space, or clearance, in per cent.: *24.*

e. Horse-power constant for one lb. M. E. P. and one revolution per minute: *.00113.*

TOTAL QUANTITIES

6. Duration of test: *Full load, six (6) hours; 25% overload, two (2) hours.*

7. Gas, or oil, consumed:

Full load . . . . *203.3 lbs., gasolene.*
25 % overload . . . . *90.9 lbs., gasolene.*

8. Cooling water supplied to jackets: *240 lbs. per minute. (Data supplied by Dept. of Engineering and Mine Defense.)*

9. Calorific value of fuel by calorimeter test, determined by calorimeter: *18,500 B.T.U. per pound. (Data supplied by Dept. of Engineering and Mine Defense.)*

PRESSURES AND TEMPERATURES

10. Pressure at meter (for gas engine) in inches of water: *Not taken.*

11. Barometric pressure of atmosphere:

a. Reading of barometer: *(at 25° C.) 30.27 inches.*
b. Reading corrected to 32 degrees Fahr.: *30.14 inches.*

12. Temperature of cooling water:

a. Inlet: *Full load, (average) 73°.5 C.; 164°.2 Fahr.*
b. Outlet: *Full load, (average) 83°.2 C.; 181°.7 Fahr.*

13. Temperature of gas at meter (for gas engine): *Not taken.*

14. Temperature of atmosphere: *32°.9 C.*

15. Temperature of exhaust gases: *Not taken.*

DATA RELATING TO HEAT MEASUREMENTS

16. Heat units consumed per hour (pounds of oil, or cubic feet of gas per hour, multiplied by the total heat of combustion):

Full load . . . . *626,842 B. T. U.*
Overload . . . . *840,594 B. T. U.*

17. Heat rejected in cooling water, per hour:

Full load . . . . *307,400 B. T. U.*
Overload . . . . *310,840 B. T. U.*

SPEEDS

18. Revolutions per minute:
Full load .... *556.2 R.P.M.* (*Average.*)
Overload .... *558.0 R.P.M.* (*Average.*)
(*Unusual, due to setting of governor.*)

19. Average number of explosions per minute:
Full load .... *556.2* } *estimated*
Overload .... *558.0* } *from R.P.M.*

INDICATOR DIAGRAMS

(*Not taken.*)

20. Pressure in lbs. per sq. in. above atmosphere:

	1st Cyl.	2nd Cyl.
a. Maximum pressure	......	......
b. Pressure just before ignition	......	......
c. Pressure at the end of expansion	......	......
d. Exhaust pressure	......	......
e. Mean effective pressure	......	......

POWER

(*Direct connected, cards not taken.*)

21. Indicated horse-power:
First cylinder .... H. P.
Second cylinder .... H. P.
Total .... H. P.
22. Brake horse-power .... H. P.
23. Friction horsepower by friction diagram .. H. P.
24. Percentage of indicated horse-power lost in friction .... %

STANDARD EFFICIENCY AND OTHER RESULTS

25. Heat units consumed by engine per hour:
(*Direct connected, cards not taken.*)
a. Per indicated horse-power .... B.T.U.
b. Per brake horse-power .... B.T.U.

26. Pounds of oil or cubic feet of gas consumed per hour:
a. Per indicated horse-power: *See (21). Not taken.*
b. Per brake horse-power: *See (21). Not taken*

ADDITIONAL DATA

27. Speed variation from full to no load:
1st trial ..554 to 558 R.P.M., or 4 R.P.M., equal to .72%
2nd trial ..554 to 556 R.P.M., or 2 R.P.M., equal to .36%

28. Voltage regulation from full to no load:
112 volts to 125 volts for 5 seconds and then returned to 112 volts.

29. Thermal efficiency at full load and 25 %overload:

$$\text{Thermal Efficiency} = \frac{\text{B.T.U. Useful Output}}{\text{B.T.U. Input}}$$

One H.P. = 42.42 B.T.U. per minute.
One H.P. = 2545 B.T.U. per hour.
Useful output (see heat balances) during "full load." = 515,160 B. T. U.
Useful output (see heat balances) during "25% overload." = 214,200 B. T. U.
Total heat supplied engine during "full load." = 3,761,050 B.T.U.
Total heat supplied engine during "25% overload." = 1,681,188 B.T.U.

$$\text{Thermal Eff.} = \frac{515{,}160}{3{,}761{,}050} = .137 = 13.7\%\text{—full load.}$$

$$\text{Thermal Eff.} = \frac{214{,}200}{1{,}681{,}188} = .128 = 12.8\%\text{—overload.}$$

30. **Heat balances:**

	Full load. *B.T.U.*	*25% overload.* *B.T.U.*
1. Heat units supplied engine*	*3,761,050*	*1,681,188*
2. Heat represented in fan motor, armature, series, shunt, and interpole fields	*115,888*	*51,816*
3. Heat represented in useful output†	*515,160*	*214,200*
4. **Heat lost in the exhaust, radiation, conduction, etc.**	*1,285,602*	*793,492*

---

* *18,500 B.T.U. × 203.3 lbs. = 3,761,050*
18,500 B.T.U. × 90.875 lbs. = 1,681,188

† *Full load.*
1.H.P. = 42.416 B.T.U. per minute.
25.14 K.W. = 33.7 H.P.
42.416 × 33.7 = 1431 B.T.U. per minute.
1431 × 60 × 6 = 515,160 B.T.U. in 6 hours.
Overload.
56.9 B.T.U. × 31.37 = 1785 B.T.U. per minute.
1785 × 60 × 2 = 214,200 B.T.U. in 2 hours.

5. Heat carried off in the jacket water	*1,844,400*	*621,690*
Total	*3,761,050*	*1,681,188*

See calculation page 133.

b. CONTRACT GUARANTEES

31. The set fulfils its contract guarantees, as shown by the following:

	As Guaranteed	*Results of Test*	
Gas Motor Set		*Full Load*	*Overload*
H. P.	*43-54*	*36.65*	*44.98*
K.W. (including fan motor)	*27.5*	*27.36*	*33.54*
Speed (3% from full to no load) (See No. 27)	*560*	*554.0*	*558*
Voltage	*115*	*114.94*	*115.14*
Amperes	*217*	*218.77*	*272.2*
Fan Motor			
Speed	*1050*	*1040*	*1060*
Voltage	*115*	*114.94*	*115.14*
Amperes	*23.5*	*19.28*	*19.1*
H. P.	*3*	*2.97*	*2.199*
Temperatures			
Outlet—not to exceed	*85 C.*	*83.2 C.*	*92.8 C.*
Jacket water	*90 C.*	*91.33 F.*	*91.04F.*
Air temperature	*95 F.*		

c. COST OF ELECTRICAL ENERGY

32. Cost of electrical energy at switchboard:

Fuel, etc.	*Full load.*				*25% Overload.*			
used.	*Amt.*	*Cost.*			*Amt.*	*Cost.*		
	Gals.	*Per gal.*	*Total.*	*Per K.W.H.*	*Gals.*	*Per gal.*	*Total.*	*Per K.W.H.*
Gasolene	*5.584*	*12.5*	*.697*	*.0277*	*.7485*	*12.5*	*.935*	*.0298*
Cylinder oil (*1.84 gals. used in 8 hours.*)	*.216*	*65*	*.140*	*.0055*	*.270*	*65*	*.176*	*.0056*
Total			*.837*	*.0332*			*1.111*	*.0354*

Note:—A large amount of cylinder oil leaked out through the gear boxes during the eight hours run.

REMARKS

During both the full and overload runs it was attempted to keep the gasolene supply to a minimum by adjustments of the "gasolene needle valve" and the "hot and cold air valve." The supply of gasolene required seemed to increase slightly during the full load run. The engine ran with the needle valve set at 2 + 1 notches for 3½ hours, when it back-fired and stopped for four minutes. The needle valve was set at 3 notches for the next 2 hours; this was changed to 2 + 2 notches during the last half hour, on account of number four cylinder missing; the setting seemed to be about right.

After four hours running the engine stopped for four minutes, the rubber hose to gasolene measuring tank was found rotted through and the gasolene supply cut off.

After 15 minutes of overload run with needle valve set at 2 + 2 notches the engine slowed down slightly and needle valve was set at 3 and timer retarded about ⅔ of the distance between notches. At the end of the first hour the speed dropped, the needle valve was changed to 3 + 1 notches and the timer retarded about ¼ inch. The voltage dropped almost immediately from 115 to 105 and two minutes later the timer was advanced ⅛ inch and the voltage went back to 115.

The speed regulation throughout the run was very close except at the various times that the needle valve was changed. The records on data sheet No. 1 give a very good indication of the load, which was kept quite constant throughout, any changes being corrected at once without regard to recording periods.

During the first four hours of run no voltmeter readings were taken across shunt field, the voltage across terminals being the same as that across the shunt field including the regulating rheostat.

All temperatures assumed a fairly constant value during the full load test, as they also did in the overload test except those of the generator parts. All were, however, within the limits allowed by the A. I. E. E. except the interpole field on overload, which exceeded the permissible rise by 9.9 degrees C.

The needle valve screw head is divided into ten numbered sectors, each of which contains three notches, making 30 notches to one complete turn of the screw.

FORM FOR REPORT OF TEST ON GASOLENE DRIVEN GENERATING SET NO. 5496.*

Makers, *General Electric Co.* Purchased (Date of contract), *not known.*

Rating of engine, *43-54* H. P.; *560* revs.; *6″.5* cylinders, diam.; *6″.75* stroke.

---

* Form required in Dept. of Engineering and Mine Defense, Coast Artillery School.

Rating of generator, 25 K. W., *115* volts; *217* amps. (useful output).

Rating of fan motor, *3.6* H. P.; *115* volts; *23.5* amps.

Engine No. *5496*; generator No. *189211*; fan motor No. *181506*.

Tested, *Sept. 22, 1910*. Duration at full load run *6* hours; at 25% overload run *2* hours.

Voltage at which generator compounds flat, *115* volts, and *560* R. P. M.

Gasolene consumption per hour at full load, *5.584* gallons.

Gasolene consumption per K. W. hour at full load, *1.775* pints.

Specific gravity of gasolene, *62.5* Baumé at *70* ° F. (*.727* S. G.)

Average temperatures during full load test, room, *32*°*.96* C.; water entering jackets, *73*°*.5* C.; water leaving jackets, *83*°*.2* C.; air entering radiator *40*°*.4* C.; air leaving radiator, *62*° C.

Output during full load test, *114.94* volts, *238.05* amps. = *27.36* K. W., including fan motor.

Output during 25% overload test, *115.14* volts, *291.3* amps. = *33.54* K. W., including fan motor.

Fan input, *115.14* volts, *19.1* amps. = *2.189* K. W.

Temperatures in °C at end of Full and Overload Runs.

	Temp. before test	FULL LOAD		25% OVERLOAD	
		Readings	Rise [corrected]	Readings	Rise [corrected]
Generator, frame, right	27.0	42.5	15.5	47.5	20.5
" field, shunt spool	27.5	56.0	28.5	65.0	37.5
" " inner pole spool	28.0	58.2 (74.4)	30.2 (46.4)	68.5 (87.9)	40.5 (59.9)
" commutator	27.5	49.5	22.0	54.5	29.0
" armature and connections	27.5	47.5 (52.2)	20.0 (24.7)	56.0 (76.7)	28.5 (49.2)
" pole tips	27.5	44.0	16.5	50.0	22.5
" armature core	27.5	46.0	18.5	55.0	27.5
" bearing	27.5	32.0	4.5	36.5	9.0
Fan Motor, frame	27.5	46.0	18.5	45.6	18.1
" commutator	27.0	58.5	31.5	58.0	31.0
" field spool	28.0	58.0	30.0	56.0	28.0
" armature core	27.0	49.8	22.8	51.0	24.0
Engine, main bearing	25.5	40.4	14.9	41.0	15.5
" crank pin	27.5	40.4	12.9	56.0	28.5
" oil in base	27.5	48.0	20.5	53.0	25.5
Air	25.0	31.0	6.0	34.0	9.0

Remarks: Figures in parenthesis show temperatures as calculated by resistances

GASOLENE CONSUMPTION

FULL LOAD

Time		Gross Weight lbs.	Weights				Remarks
Hrs.	Min.		Arm	Scale	Can, etc.	Net, lbs.	
10	45	130	100	30	91.5	38-8	S.G. .727 = Baumé 61 at 70° F.
11	25	25-2	24	1-2	2.5	22-10	Gasolene added to tank.
11	27	22-12	20	2-12	2.5	20-4	do
12	50	28-3	28	-3	2.5	25-11	do
2	12	26-13	24	2-13	2.5	24-5	do
2	15	28-4	28	-4	2.5	25-12	do
3	46	24-10	24	-10	2.5	22-2	do
3	48	26-9	24	2-9	2.5	24-1	do
4	53	91-8					
					Total	203-5	= 33.88 lbs. per hour = 5.584 gals. per hour.

OVERLOAD

Hrs.	Min.	Gross Weight lbs.	Arm	Scale	Can, etc.	Net, lbs.	Remarks
5	48	91-8		91-8		91-8	[Quantities following dashes indicate 1-16th of pounds.]
5	48	25-12	24	1-12	2.5	23-4	
5	54	24-10	24	-10	2.5	22-2	
6	40	27	24	3	2.5	24-8	
6	45	27	24	3	2.5	24-8	
7	45	95 (can and oil)					
					Total	185-14	
					less	95	

90-14 lbs. = 45.437 lbs. per hr.
7.485 gals. per hr.

1 gallon = 231 cu. in.

$\frac{1728}{231}$ = 7.48 gals. per cu. ft.

$\frac{62.425}{7.48}$ = 8.35 lbs. per gal. water at 39°.1 F.

$8.35 \times .727$ = 6.07 lbs. gasolene per gallon.

$\frac{203.3}{6.07}$ = 33.50 gallons gasolene, total.

$\frac{203.3}{6}$ = 33.9 lbs. per hour.

$\frac{33.50}{6}$ = 5.584 gals. per hour.

$\frac{5.584 \times 8}{25.14}$ = 1.775 pints per K. W. hour.

CALCULATIONS

1 H. P. 42.416 B. T. U. per minute.
1 K. W. 42.416 ÷ 746 = 56.9 B. T. U. per minute.

B. T. U. Loss

Fan Motor: Full load,
2.215 K. W. × 56.9 × 60 × 6 = 45,370 B. T. U.

Generator Armature: Full load,
2.46 K. W. × 20490 = 50,370 B. T. U.

Series Field: Full load,
.217 K. W. × 20490 = 4,443 B. T. U.

Interpole Field: Full load,
.474 K. W. × 20490 = 9,705 B. T. U.

Shunt Field: Full load,
.293 K. W. × 20490 = 6,000 B. T. U.

45,370
50,370
4,443
9,705
6,000

Total = 115,888 B.T.U.

Jacket Water: Full load,

Lbs. per min. Temp. rise No. min.
240 × 92.7 × 15 = 333,600
240 × 34.8 × 12 = 100,000
240 × 17.1 × 15 = 61,550
240 × 18.7 × 10 = 44,890
240 × 16.2 × 15 = 58,350
240 × 18.4 × 20 = 88,300
240 × 18.0 × 10 = 43,200
240 × 14.8 × 10 = 35,510
240 × 19.8 × 18 = 85,550
240 × 18.7 × 12 = 53,850
240 × 19.1 × 13 = 59,600
240 × 19.5 × 11 = 51,500
240 × 18.9 × 36 = 163,300
240 × 15.3 × 30 = 110,100
240 × 15.3 × 30 = 110,100
240 × 18.0 × 40 = 172,700
240 × 18.0 × 28 = 121,000
240 × 18.0 × 35 = 151,200

1,844,400 B. T. U. total.

Fan Motor: Overload,
2.199 K. W. × 683 = 15,000 B. T. U.
Generator Armature: Overload,
3.90 K. W. × 683 = 26,610
Series Field: Overload,
.345 × 683 = 2,356
Interpole Field: Overload,
.780 K. W. × 683 = 5,324
Shunt Field: Overload,
.370 K. W. × 683 = 2,526

51,816 B. T. U. total.

Jacket Water: Overload,

Lbs. per min.		Temp. rise		No. min.		
240	×	18.0	×	3	=	12,950
240	×	21.6	×	17	=	88,150
240	×	23.4	×	13	=	73,000
240	×	22.3	×	18	=	96,300
240	×	21.6	×	18	=	93,300
240	×	21.6	×	18	=	93,300
240	×	19.8	×	18	=	85,500
240	×	22.0	×	15	=	79,180

Total = 621,680 B. T. U.

5. e. H.P. constant for 1 lb. M.E.P. and 1 R.P.M. per min.

$$\text{H.P.} = \frac{\text{PLAN}}{33000} = \frac{1 \times \frac{6\frac{3}{4}}{12} \times \frac{\pi}{4} (6\tfrac{1}{2})^2 \times 2}{33000} = .00113.$$

ELECTRICAL LOSSES AND TEMPERATURE RISE

In calculating the electrical losses the mean of resistances, at start and finish of each run were taken as the most probable average during that run. They are the total internal resistances, including the brush contacts. For usual methods see standardization rules A.I.E.E.

Armature:

Before test, temp. = 27°.5 C.			After full load run, 6 hours			After 25% overload run, 2 hours		
V	I	R_a	V	I	R_a	V	I	R_a
1.74	41.5	.0419	.86	20.3	.0424	1.665	37.8	.0440
1.66	41.5	.0400	.88	20.4	.0431	1.26	25.9	.0487
1.22	29.0	.0420						
	mean	.0413		mean	.0428		mean	.0464

$$R_a \text{ at } 0^\circ \text{ C} = \frac{.0413}{1 + 27.5 \times .0042} = 0.351 \text{ ohms.}$$

$$\frac{.0428 - .0351}{.0351 \times .0042} = 52^\circ.2 \text{ C., temperature after full load run.}$$

$$\frac{.0464 - .0351}{.0351 \times .0042} = 76^\circ.7 \text{ C., temperature after } \tfrac{1}{4} \text{ overload run.}$$

Full load, $I = 218.77 + 4.10 + 19.28 = 242.15$ amp.

$$\text{Loss} = \overline{242.15}^2\left(\frac{.0413 + .0428}{2}\right)\frac{1}{1000} = 2.46 \text{ K.W., full load.}$$

Twenty-five per cent. overload, $I = 272.2 + 19.10 + 4.42 = 295.72$ amp.

$$\text{Loss} = \overline{295.72}^2\left(\frac{.0428 + .0464}{2}\right)\frac{1}{1000} = 3.90 \text{ K.W., overload.}$$

Series Field:

Before test, temp. = 27°.5 C.			After full load run, 6 hours			After 25% overload run, 2 hours		
V	I	R_c	V	I	R_c	V	I	R_c
.10	27.2	.00368	.105	26.0	.00404	.11	26.4	.00417
.15	42.0	.00357	.152	37.8	.00402	.14	34.8	.00403
	mean	.00363		mean	.00403		mean	.00410

$$R_c \text{ at } 0^\circ \text{ C.} = \frac{.00363}{1 + 27.5 \times .0042} = .00314.$$

$$\frac{.00403 - .00314}{.00314 \times .0042} = 67^\circ.5 \text{ C., temperature after full load run.}$$

$$\frac{.00410 - .00314}{.00314 \times .0042} = 72^\circ.8 \text{ C., temperature after overload run.}$$

Full load, $I = 218.77 + 19.28 = 238.05$ amp.

$$\text{Loss} = \overline{238.05}^2\left(\frac{.00363 + .00403}{2}\right)\frac{1}{1000} = .217 \text{ K.W., full load.}$$

Overload, $I = 272.20 + 19.10 = 291.30$ amp.

$$\text{Loss} = \overline{291.30}^2\left(\frac{.00403 + .00410}{2}\right)\frac{1}{1000} = .345 \text{ K.W., overload.}$$

Interpole Field:

Before tests, temp. = 28° C.			After full load run, 6 hours			After overload run, 2 hours		
V	I	R_i	V	I	R_i	V	I	R_i
.31	41.5	.00747	.33	37.4	.00882	.35	38.3	.00914
.22	29.5	.00746	.225	26.0	.00866	.17	18.7	.00909
.31	42.0	.00738						
	mean	.00744		mean	.00874		mean	.00912

$$R_s \text{ at } 0° \text{ C.} = \frac{.00744}{1 + 28.0 \times .0042} = .00666 \text{ ohms.}$$

$$\frac{.00874 - .00666}{.00666 \times .0042} = 74°.4 \text{ C., temperature after full load run.}$$

$$\frac{.00912 - .00666}{.00666 \times .0042} = 87°.9 \text{ C., temperature after overload run.}$$

Full load, $I = 218.77 + 4.10 + 19.28 = 242.15$ amp.

$$\text{Loss} = \overline{242.15}^2 \left(\frac{.00744 + .00874}{2}\right)\frac{1}{1000} = .474 \text{ K.W., full load.}$$

Overload, $I = 272.2 + 19.10 + 4.42 = 295.72$ amp.

$$\text{Loss} = \overline{295.72}^2 \left(\frac{.00874 + .00912}{2}\right)\frac{1}{1000} = .780 \text{ K.W., overload.}$$

Shunt Field:

Before test, temp. = 27°.5 C.			After full load run, 6 hours			After overload run, 2 hours		
V	I	R_{sh}	V	I	R_{sh}	V	I	R_{sh}
25.8	1.60	16.13	.82	4.38	18.72	81.5	4.25	19.18
25.5	1.58	16.14	.82	4.35	18.85	81.5	4.30	18.95
	mean	16.14		mean	18.79		mean	19.07

$$R_{sh} \text{ at } 0° \text{ C.} = \frac{16.14}{1 + 27.5 \times .0042} = 14.46 \text{ ohms.}$$

$$\frac{18.79 - 14.46}{14.46 \times .0042} = 71°.3 \text{ C., temperature after full load run.}$$

$$\frac{19.07 - 14.46}{14.46 \times .0042} = 75°.9 \text{ C., temperature after overload run.}$$

Full load, $I = 4.10$ amp.

$$\text{Loss} = \overline{4.10}^2 \left(\frac{16.14 + 18.79}{2}\right)\frac{1}{1000} = .293 \text{ K. W., full load.}$$

Overload, $I = 4.22$ amp.

$$\text{Loss} = \overline{4.22}^2 \left(\frac{18.79 + 19.07}{2}\right)\frac{1}{1000} = .370 \text{ K.W., overload.}$$

DATA SHEET No. 1.

	Time		Speed	Ammeter [Amperes]					Voltmeter [Volts]			Weight of gas per hr.	Remarks
	Hr.	Mi.	r.p.m.	Line	Arma.	Shunt Field and Rheostat	Motor	Shunt	Brushes	Line	Shunt Field	Lbs.	K.W.
Full Load	10	45	568	217.5		4	20			115.5			25.15
	11	15	564	220		4	19			113.5			24.97
	11	36	532	221		4.25	19.5			116			25.62
	11	45	528	219		4.25	19.5			116			25.40
	11	55	572	232.5		4	19			114			26.50*
	12	00	572	217.5		4	19			115			25
	12	10	560	216		4	19			115			24.82
	12	27	542	220		4	19			114.5			25.19
	12	42	560	217.5		4	19.5			115			25.02
	12	57	540	217.5		4.25	19.5			115.5			25.12
	1	17	562	217.5		4	19			114.5			24.88
	1	42	568	217.5		4	19			114.5			24.88
	2	20	572	217.5		4.1	19			115			25.02
	2	43	556	218		4	19.5	4.25		115	80.5		25.08
	3	10	555	217.5		4.2	19	4.15		114	79		24.80
	3	50	546	216		4.35	19.5	4.35		115.5	82		24.94†
	4	20	552	218		4.35	19.5	4.35		115	82		25.08
	4	52	562	217.5		4.38	19.5	4.38		115.5	82		25.13
	Average			218.77		4.10	19.28			114.94			25.14
Overload	5	45	556	270		4.45	19.5	4.45		116.5	80		31.45
	6	13	560	272.5		4.6	19	4.65		114	85.5		31.08
	6	25	560	273		4.65	19	4.65		115.5	87		31.54
	6	50	564	274		4.35	19.2	4.35		115	82.2		31.51
	7	10	552	273		4.35	19	4.35		115.5	82.5		31.55
	7	30	556	272		4.25	19	4.25		114.5	81.5		31.15
	7	45	558	272		4.30	19	4.30		115	81.5		31.28
	Average			272.2		4.42	19.1			115.14			31.37

* New speed indicator.

† Speed at 4:05.

DATA SHEET No. 2

Temperatures °C

	Time		Room	Water entering jacket	Water leaving jacket	Air entering radiator	Air leaving radiator	Generator frame R	Generator field shunt spool	Generator commutator	Generator armature and connections	Generator pole tips	Generator armature core	Generator interpole spool	Fan motor frame	Fan motor commutator	Fan motor field spool	Fan motor armature core	Engine main bearing	Crank pin	Oil in base	Barometer	Generator bearing
	Hrs.	Min.																					
	9	20	25	25.5	28	26.5	25	27	27.5	27.5	27.5	27.5	27.5	28	27.5	27	28	27	25.5	27.5	27.5	30.27	27.5
	11	00	31.5	68	77	39	68	32	32.5			37.5		40.5	34		37		32				33
	11	15	33	73	82.5	39	61	34	42.5			41		46	37		42		34.5				34
	11	25	34.6	74.6	85	42	63.5	36.5	47			42		51	40		45		39				35
	11	40	34	77	88	42	64.5	38	49.5			43.5		53.5	40.8		48		37.5				35
Full load	12	00	33.5	77.8	88	42	64.5	40	52			45		56	42.5		50.5		38.8				36
	12	10	33.5	77	87	42	64	41	53			45		56.8	43		52		39.5				35
	12	20	33.5	77	86.8	40	64	41.6	54			45		57.5	44		53		40				35
	12	32	34	78	89	41	65	42.4	55			45		58	44.5		54		40.2				34.5
	12	42	33.5	78	88	41	64.8	42.4	55			45		58	44.5		55		40.4				33
	1	00	33.6	78	89	42	65	43	53.5			45		58.6	45.4		56		41				35.6
	1	12	33	78.6	89	42	65.3	43.2	56.5			45.8		59.2	45.8		56.8		41				36
	1	25	33.8	78.4	89	42	64.8	43.8	57			46		60	45.8		57		41.8				36

Full load	1	36	33.6	78	88.8	42	64.4	44	57			45		59.2	46.2		57.4		41.8				35
	2	12	33	78.5	89.8	41	65	44.6	58			46.5		61	47		58.5		42				36
	2	42	34.5	72.5	81	39.5	60.5	44.5	57			46		59	46.8		58.5		42				37
	3	10	34	71.5	80	40	60	44.4	57			46		59.8	46.8		58.5		42				37
	3	50	32.8	74	84	39	62.2	44.2	56.4			45.4		58.2	46		58		41.8				36
	4	18	33.8	78	88	39.8	64.8	44	56.6			45.4		58.8	46.5		58		41.5				34.4
	4	50	31	76.8	86.8	40	63.8	42.5	56	49.5	47.5	44	46	58.2	46	58.5	58	49.8	40.4	57	48		32
	5	48	30.2	67	77	36.5	57	41.5	48.8			41		51	42.2		52		37.4				32
½ Overload	6	05	32.8	80	92	38.5	66	42	52			45		56	42.8		52		38.5				34
	6	18	31.8	83	96	39.5	65.4	43.3	57			47		60.2	43.5		53.5		39.5				34
	6	36	33.2	84	96.4	39.5	66.5	44.6	60			48		63.4	44		55		40.5				34.5
	6	54	33.5	85	97	41	66	45.8	61			49		65.6	44.8		55.4		40.6				34.5
	7	12	33.2	83	95	39.5	66	47	63			49		67.4	45		56		41				35.8
	7	30	33	83	94	40.5	66	47.2	64.5			50		68	45.5		56		41				36
	7	45	34	82.6	94.8	39	65	47.5	65			50		68.5	45.6		56		41				36.2
	8	00								54.5	56		55			58		51		56	53		

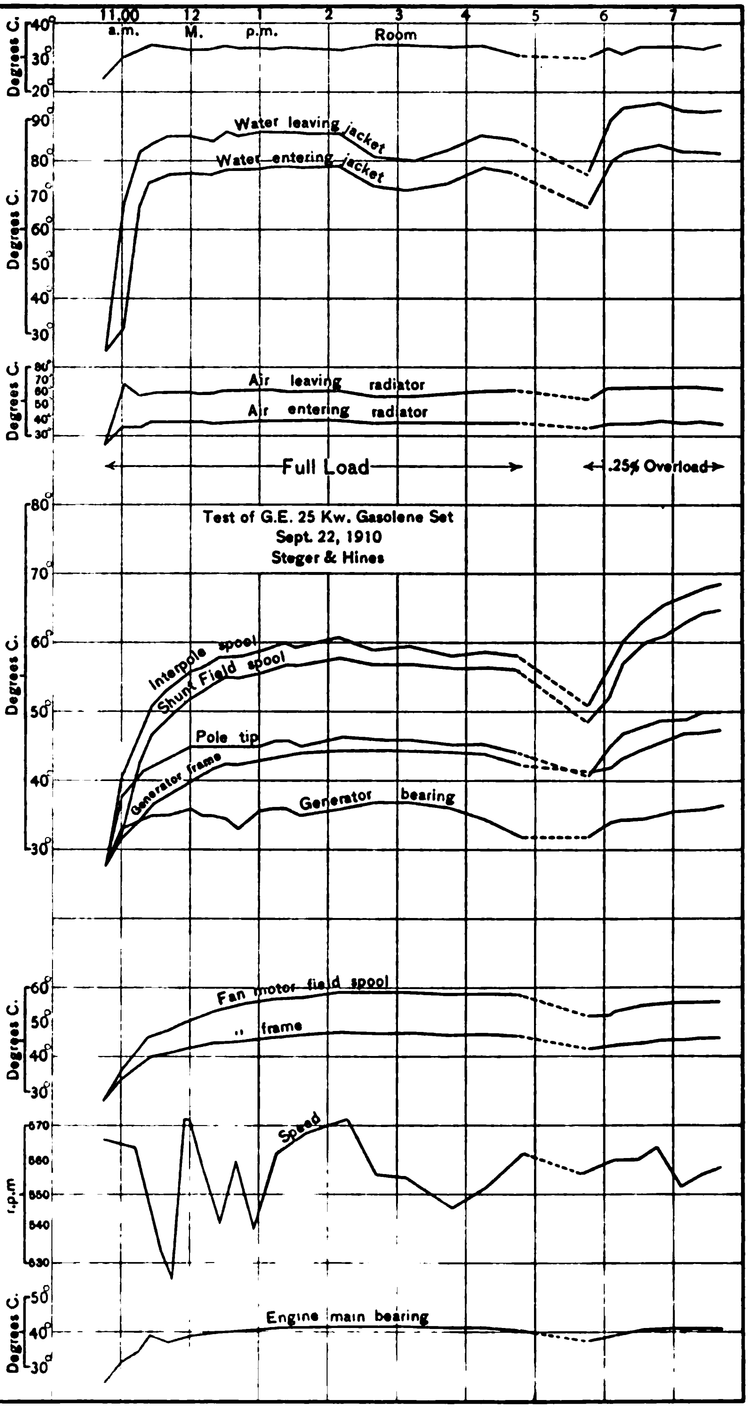

11.00 a.m.
12 M.
1 p.m.
2
3
4
5
6
7
Degrees C.
40°
30°
20°
Room
Degrees C.
90°
80°
70°
60°
50°
40°
30°
Water leaving jacket
Water entering jacket
Degrees C.
80°
70°
60°
50°
40°
30°
Air leaving radiator
Air entering radiator
Full Load
.25% Overload
Test of G.E. 25 Kw. Gasolene Set
Sept. 22, 1910
Steger & Hines
Degrees C.
80°
70°
60°
50°
40°
30°
Interpole spool
Shunt Field spool
Pole tip
Generator frame
Generator bearing
Degrees C.
60°
50°
40°
30°
Fan motor field spool
" frame
r.p.m.
570
560
550
540
530
Speed
Degrees C.
50°
40°
30°
Engine main bearing

FIG. 12.

I. ADAPTABILITY TO SERVICE CONDITIONS

Advantages:

1. Small space occupied as compared with steam plant.
2. Can be quickly started and stopped at any time.
3. Simplicity.
4. Fuel is consumed only while the engine is running.
5. Economy of fuel.
6. Comparatively low cost of power and attendance.
7. Easier to protect than steam plant of same power.
8. Number of attendants required is less than for steam plant of same power.

Disadvantages:

1. Inability to carry overloads unless specially designed.
2. Decreased efficiency when run at less than full load.
3. Cannot start under load.
4. High average of intelligence and experience are required for best operation.

After considering the above advantages and disadvantages it is believed that this set is suitable for the following installations:

1. To supply power for 60-inch searchlights.
2. As reserve plant for batteries, or groups of batteries.

SUPPLEMENTARY TESTS

A series of tests were made between November 11th and 23rd, 1910, to determine the gasolene consumption and thermal efficiency of the set at various loads and for three conditions of exhaust, viz.:—

1. The regular installation at the school.
2. A straight exhaust pipe 21 feet long and 3½ inches in diameter.
3. The same straight exhaust pipe with the service muffler on the end of same.

Tests were made at ¼, ½, ¾, full, and 1¼ loads, except in the first case, where the ¼ load was omitted.

Curves of consumption and efficiency were constructed as shown in Fig. 13.

The heat value of the gasolene was determined by the Geological Survey, Washington, D. C. Report is appended (page 147).

Ammeters were calibrated with a standard instrument recently received from the factory and found correct by potentiometer calibration made by Captain C. C. Carter, Coast Artillery Corps, Instructor.

The voltmeter used was one of four checked and found to read the same when corrected for index error.

The scales were checked by standard weights. The half hour weights were read to the nearest 4 ounces and are assumed to be correct to the nearest 2 ounces.

The speed indicator was graduated to 5 R.P.M., and could be read to the nearest R.P.M., by interpolation.

The thermometers used were compared and found to read together at room temperatures.

All electrical instruments were kept short circuited except when read, except the external circuit ammeter (capacity 600 amperes) which was kept continuously in the circuit.

While the set was being regulated and heated up preparatory for the ¼ and 1¼ loads, with straight exhaust, cylinder oil was poured into the crank chamber through one of the ventilators, unknown to the operators. About 2 gallons of oil was poured in, in this manner, and it is evident that the inflowing stream impigned upon the crank shaft of No. 3 cylinder, and an excess amount splashed into the cylinder, quickly carbonizing and partially short circuiting the spark plug, and necessitating the same being changed at the end of the ¼ load test.

The results of these tests were therefore in doubt and the latter (1¼ load) has been disregarded in constructing the efficiency and consumption curves.

The data for the test at ½ and ¾ loads, with exhaust regularly installed at the school, shows some inconsistencies in the weights of gasolene consumed during different periods of equal length, and is probably due to irregular running, both noticed and unnoticed. (See notes.) These points were not entirely disregarded in constructing the curves, but a mean line drawn between them, which appears consistent with the other curves.

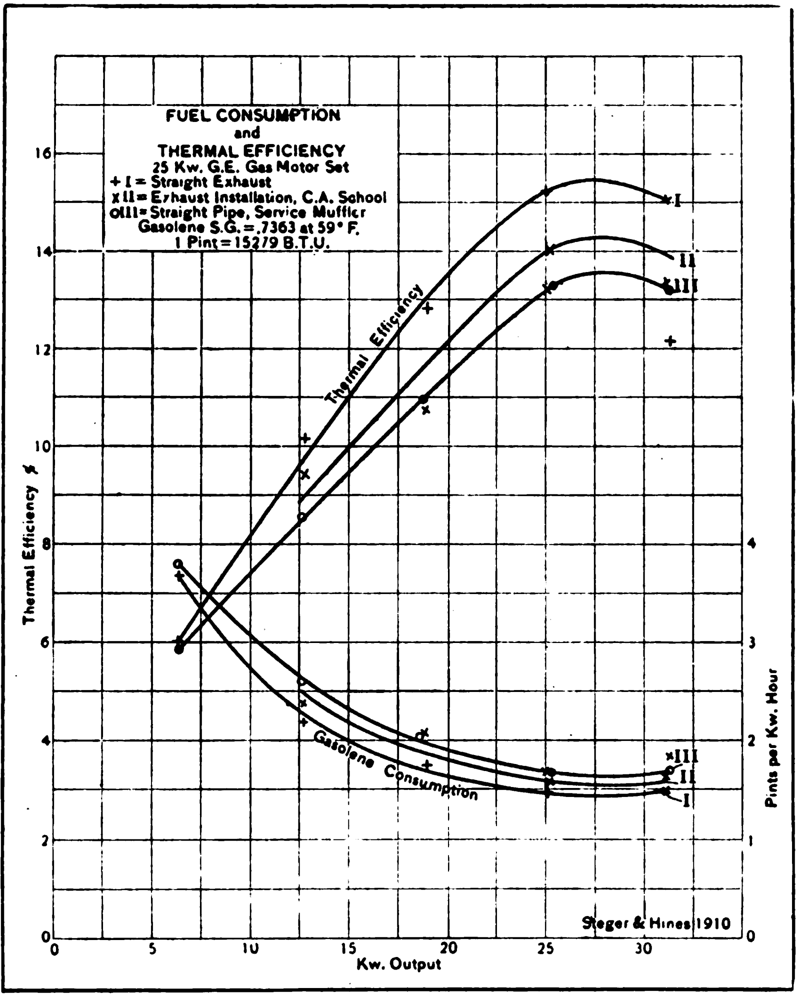

FUEL CONSUMPTION
and
THERMAL EFFICIENCY
25 Kw. G.E. Gas Motor Set
+ I = Straight Exhaust
x II = Exhaust Installation, C.A. School
o III = Straight Pipe, Service Muffler
Gasolene S.G. = .7363 at 59° F.
1 Pint = 15279 B.T.U.
Thermal Efficiency
Gasolene Consumption
I
II
III
Thermal Efficiency %
Pints per Kw. Hour
Kw. Output
0
2
4
6
8
10
12
14
16
0
1
2
3
4
0
5
10
15
20
25
30
Steger & Hines 1910

FIG. 13.

Calculation Table.

$$\frac{62.425 \times .7363 \times 231}{1728} = 6.14 \text{ lbs. per gallon of gasolene.}$$

$$\frac{2545}{.746} = 3412 \text{ B. T. U. per K. W. Hour, output.}$$

K. W.	Gasolene Lbs.	Duration of Test, Hours	Gasolene Pounds per K.W. Hour	Gasolene Pints per K. W. Hour at 15 C.	B. T. U. per K.W. Hr. Input	Thermal Efficiency of Set.
Useful Output			$\frac{\text{lbs. Gasolene}}{\text{K. W.} \times \text{No. hrs.}}$	$\frac{\text{lbs. gas. per K.W. hr.} \times 8}{6.14}$	lbs. gas. per K. W. hr. × 19908	$\frac{\text{B.T.U. per K.W. hr. useful output}}{\text{B.T.U. input per K.W. hr.}}$
Regular Exhaust Installation, C. A. School.						
12.73	46.25	2	1.818	2.368	36200	9.43
18.88	59.80	2	1.588	2.069	31600	10.78
25.21	61.69	2	1.223	1.593	24350	14.01
25.09	32.44	1	1.293	1.684	25740	13.25
31.22	70.88	2	1.135	1.478	22600	15.09
31.18	39.88	1	1.279	1.666	25470	13.40
Straight Exhaust Pipe.						
6.36	36.13	2	2.841	3.702	56600	6.03
12.68	42.50	2	1.677	2.185	33400	10.21
19.02	50.69	2	1.332	1.735	26520	12.86
25.02	56.13	2	1.121	1.460	22320	15.29
31.31	88.00	2	1.405	1.830	27970	12.19
Service Muffler, Straight Pipe.						
6.32	36.81	2	2.912	3.795	58000	5.88
12.56	50.06	2	1.993	2.597	39680	8.60
18.74	58.44	2	1.560	2.032	31050	10.98
25.34	65.09	2	1.286	1.675	25610	13.82
31.29	80.90	2	1.293	1.684	25740	13.25

LOG KEPT DURING EFFICIENCY TESTS OF 25 K. W. DIRECT CONNECTED GAS MOTOR SET

November 11, 1910.

Before the half load test the air and needle valves were carefully adjusted so that the voltage dropped one volt on changing the needle valve ½ notch in either direction, also a similar drop in voltage would take place on changing the air valve two notches either way.

At the beginning of the regular test the needle valve was set at 2 plus 1 notches and the air valve 6 notches from C towards H.

At 12:04 p.m., when the run was half over, the needle valve was changed to 2 plus ½ notches in an effort to reduce the gasolene consumption. It was further reduced to 2 at 12:16 p.m., and the voltage dropped, showing that the setting 2 plus ½ notches was the least setting that would give a proper speed regulation for the load.

The valve was consequently reset at 12:20 p.m., to 2 plus ½ notches, where it remained for the rest of the ½ load test. The original setting of the air valve was found to be correct.

Before beginning the ¾ load test, the load was put on and the needle and air valves so adjusted that a change of ⅓ notch in the former or 2 notches in the latter, in either direction, would reduce the voltage. The original setting for the ½ load was therefore maintained throughout the run.

November 14, 1910.

The engine was first started and put under load for nearly one hour before the run was commenced, in order that uniform conditions would obtain.

The full load run was then started with the needle valve set at 2 plus 1 notches.

At 10:30 a smoky exhaust was noted and the needle valve setting was cut down to 2 plus ½ notches.

At 11:00 a.m., knocking was noted in cylinder No. 3, and the needle valve was still further closed to 2; the knocking decreased and finally stopped.

At 12:50 p.m., the engine "backfired," and the needle valve was opened to 2 plus ½ notches.

The 1¼ load test followed immediately after the full load run and the needle valve was set for 2 plus 1 notches for the entire run.

November 15, 1910.

On this date the several runs were commenced with the straight exhaust, which consisted of a straight galvanized iron pipe 21 feet long and 3½ inches in diameter, connected directly to the exhaust chamber of the engine.

The ½ load run only was made on this date, with needle valve setting at 1 plus 2 notches. The run was regular except that at about 3:16 p.m., a circuit breaker was opened evidently by accident and the load dropped from 100 amperes to 85 amperes until corrected at 3:17 p.m.

November 16, 1910.

The ¾ and full load tests, engine with straight exhaust, were run on this date. The valve settings were as follows: Needle valve set at 2, air valve at 8 notches from C towards H, for ¾ load; 2 plus 0 for needle valve, with air valve set at 10 notches from C towards H, under "full load."

November 17, 1910.

For the ¼ load the needle valve was set at 1 plus 2½ notches, with air valve 9 notches from C towards H, for the first part of the run. At 12:20 p.m. the needle valve was changed to 2, in order to stop "missing" which was noted at this time.

As this did not entirely remove the trouble, the air valve at 1:20 p.m. was set at 11 notches from C towards H. Neither of these changes entirely corrected the missing and upon further investigation it was found that cylinder No. 3 was not firing, due to the porcelain insulation inside the spark plug becoming badly coated with carbon, causing a short circuit at this point, the spark being made there instead of at the spark gap.

During the 1¼ load run the needle valve was set at 2 plus 2 notches, with the air valve 4 notches from C towards H. At the start and for the first part of the run, the timer lever was set ⅓ way from R towards S. At 3:25 p.m., the timer was advanced to the "Run" position, but had to be moved back to the setting first given in order to retain regular explosions. At the same time the needle valve was reset at 2 plus 1 notches, with the air valve 5 notches from C towards H, and so retained for the rest of the test.

November 18, 1910.

On this date the run with muffler installed on the end of the straight exhaust was commenced.

For the ¼ load run the needle valve setting to start was 2 plus 1½ notches, with air valve 4 notches from C towards H. Irregular explosions were noted and the needle valve was changed to 2 plus 2 notches, with air valve at 12 notches from C towards H. (1:15 p.m.)

An occasional "miss" was noted in cylinder No. 4 at 1:35 p.m. and the following needle valve and air valve settings were tried in an effort to remove the same:—

Needle valve 2 plus 1½ notches, with air valve 14 notches from C towards H.

Needle valve 2 plus 2 notches, with air valve 6 notches from C towards H.

Needle valve 2 plus 1½ notches, with air valve 10 notches from C towards H.

The last setting seemed to give the best results, so no further change was made.

One-half load, the needle valve setting was 2 plus 1½ notches, with air valve set 14 notches from C toward H.

November 21, 1910.

For the ¾ load the needle valve was set at 2 plus 1 notch, with air valve at 11 notches from C toward H.

The same setting of the needle valve was retained for both the "full load" and 1¼ load, with the air valve set in the first case at 4 notches from C towards H, and in the second case 9 notches from C towards H.

During all the runs on this date exceedingly steady voltage was particularly noticed.

The fan motor bearing on the overload run on the 21st inst., heated up to 64°.2 C. The lubrication was sufficient and nothing unusual could be found the matter with the bearing to cause this undue heating.

November 23, 1910.

For both the full load and the 1¼ load runs, on this date, with regular exhaust, the needle valve was set at 2 plus 1 notch. Air valve 5 notches from C towards H.

REPORT ON TEST OF GASOLENE

Department of the Interior
Bureau of Mines
Washington, D.C., December 28, 1910.

Major Richmond P. Davis,
Director, Coast Artillery School,
Fort Monroe, Va.,

Sir:—

Mr. Irving C. Allen, petroleum chemist, reports on a sample of gasolene received from you for calorimetric determination as follows,

Laboratory No. 277.

Specific gravity at 15° C.	0.7363
Calories per gram	11060
(B. T. U. per pound	19908)

Very respectfully,
Van H. Manning, Chief Clerk.

[Some additional information on gasolene engines appended to the original report, and all data sheets except one, which indicates the record kept, are omitted here.—EDITOR.]

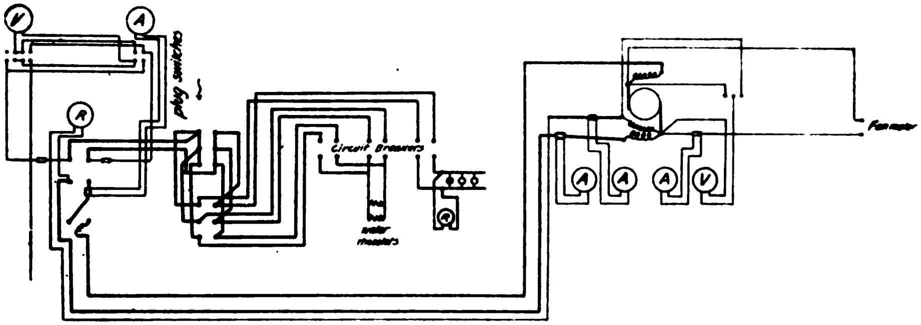


FIG. 14.
DIAGRAM OF CIRCUITS
Test of 25 K. W. General Electric Gasolene Set

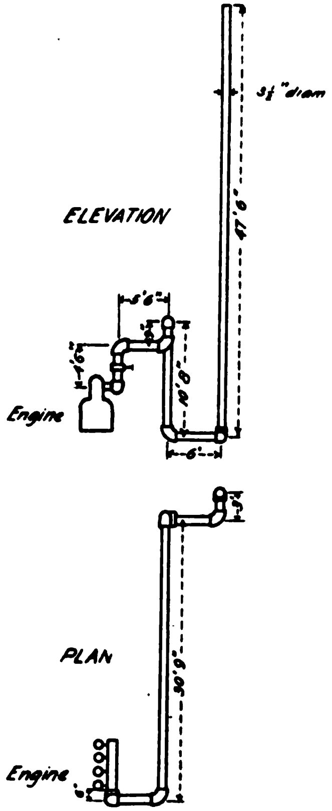


FIG. 15.
EXHAUST PIPING, GENERAL ELECTRIC 25 K. W. GASOLENE SET, COAST ARTILLERY SCHOOL

EFFICIENCY TEST OF 25 K.W. DIRECT CONNECTED GAS MOTOR SET, COAST ARTILLERY SCHOOL

(Special Exhaust Installation.) Straight Pipe 21′ long, 3½″ diameter.

Time	I Armature	Term. Volts		I Shunt Field		I Fan Motor		R.P.M.		Ther. entering Jacket	Ther. leaving Jacket	Ther. Room	K.W. Output
		+ .2		+ .02		+ .2						Inst. Correction	
		Read	Corr.	Read	Corr.	Read	Corr.	Read	Corr.				
November 15, 1910													
1.59	112.0	115.0	115.2	4.28	4.30	20.5	20.7	485	551	59.0	67.2	18.2	12.90
2.15	112.0	114.6	114.8	4.22	4.24	20.5	20.7	485	551	56.5	65.8	22.3	12.86
2.29	110.0	114.6	114.8	4.20	4.24	20.5	20.7	485	551	57.2	65.3	23.0	12.63
2.45	112.0	114.0	114.2	4.18	4.20	20.5	20.7	485	551	57.2	65.2	22.5	12.79
3.00	109.0	115.0	115.2	4.30	4.32	20.5	20.7	485	551	56.8	65.3	24.2	12.56
3.15	110.0	115.0	115.2	4.29	4.31	20.5	20.7	485	551	55.7	63.0	20.0	12.67
3.30	109.0	115.5	115.7	4.39	4.41	20.5	20.7	485	551	55.2	62.7	20.6	12.61
3.45	108.0	115.6	115.8	4.40	4.42	20.5	20.7	485	551	56.0	63.7	21.4	12.50
3.59	109.0	115.7	115.9	4.40	4.42	20.5	20.7	485	551	57.0	64.2	22.0	12.63
												mean =	12.683
November 16, 1910													
8.17	165.0	115.0	115.2	4.28	4.30	20.5	20.7	487	553	56.8	65.7	17.4	19.02
8.30	165.0	115.0	115.2	4.22	4.24	20.0	20.2	487	553	58.5	67.2	17.8	19.02
8.45	165.0	114.5	114.7	4.19	4.21	20.0	20.2	487	553	58.0	66.9	18.0	18.94
9.00	166.0	115.5	115.7	4.29	4.31	20.0	20.2	487	553	58.8	67.4	19.0	19.21
9.14	165.0	115.0	115.2	4.28	4.30	20.0	20.2	487	553	60.0	68.8	19.0	19.02
9.30	166.0	115.0	115.2	4.25	4.27	20.0	20.2	487	553	59.5	68.0	19.0	19.13
9.47	165.0	114.8	115.0	4.23	4.25	20.0	20.2	487	553	59.5	68.0	20.2	18.98
10.00	164.0	114.4	114.6	4.21	4.23	20.0	20.2	487	553	59.7	68.3	20.2	18.80
10.13	165.0	115.5	115.7	4.31	4.33	20.0	20.2	487	553	60.5	69.2	21.6	19.10
												mean =	19.024
November 16, 1910													
10.28	217.0	115.5	115.7	4.38	4.40	19.9	20.1	487	553	62.4	71.9	20.0	25.11
10.45	217.0	115.5	115.7	4.38	4.40	19.9	20.1	487	553	65.0	74.7	24.0	25.11
10.59	217.0	115.0	115.2	4.31	4.33	19.9	20.1	487	553	66.0	75.5	25.2	25.01
11.15	217.0	115.0	115.2	4.29	4.31	19.9	20.1	487	553	66.5	76.0	24.5	25.01
11.29	217.0	115.2	115.4	4.29	4.31	19.9	20.1	487	553	67.0	76.6	23.2	25.04
11.45	217.0	115.0	115.2	4.28	4.30	19.9	20.1	487	553	67.2	76.8	23.0	25.01
12.00	217.0	114.9	115.1	4.26	4.28	19.9	20.1	487	553	66.5	76.0	22.5	24.99
12.15	217.5	114.5	114.7	4.25	4.27	19.9	20.1	487	553	68.2	78.0	22.6	24.96
12.28	217.5	114.5	114.7	4.23	4.25	19.9	20.1	487	553	67.5	77.4	22.0	24.96
												mean =	25.022

ADDITIONAL INFORMATION ON GASOLENE ENGINES

(From *American Motorist*, September, 1910)

CHART I.

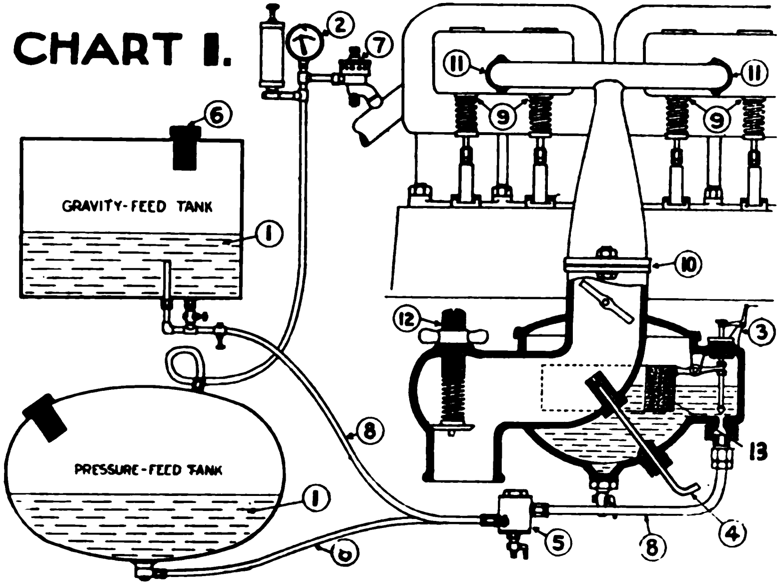


CHART II.

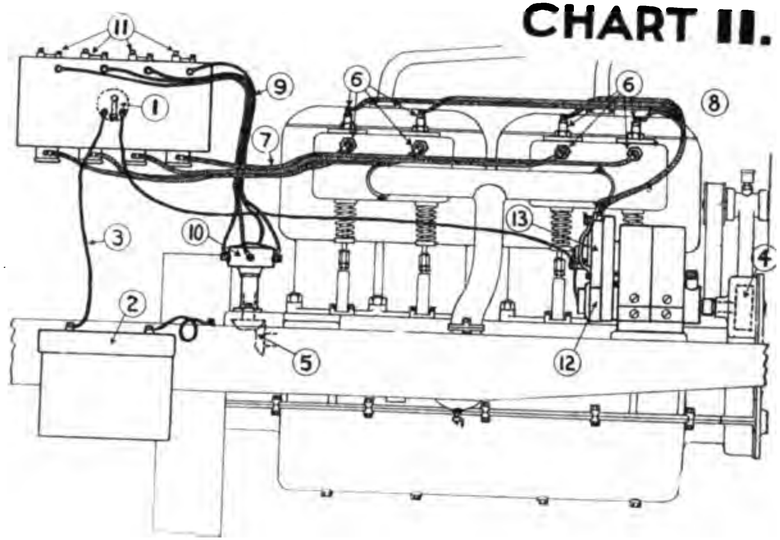


CHART III.

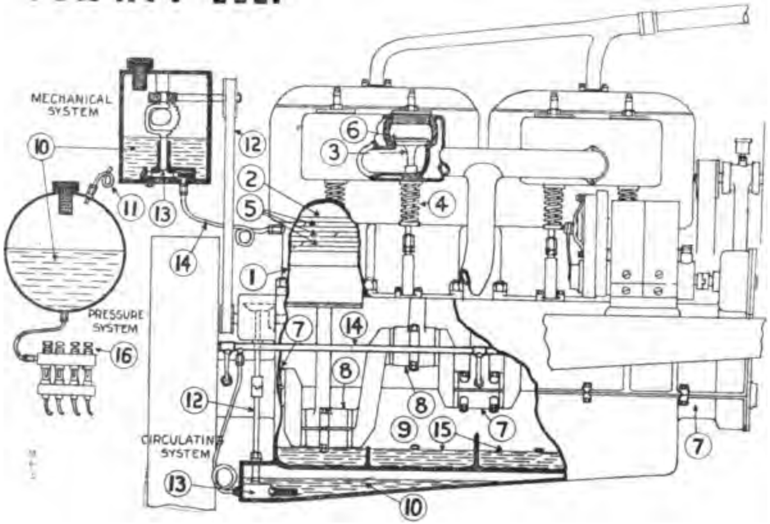
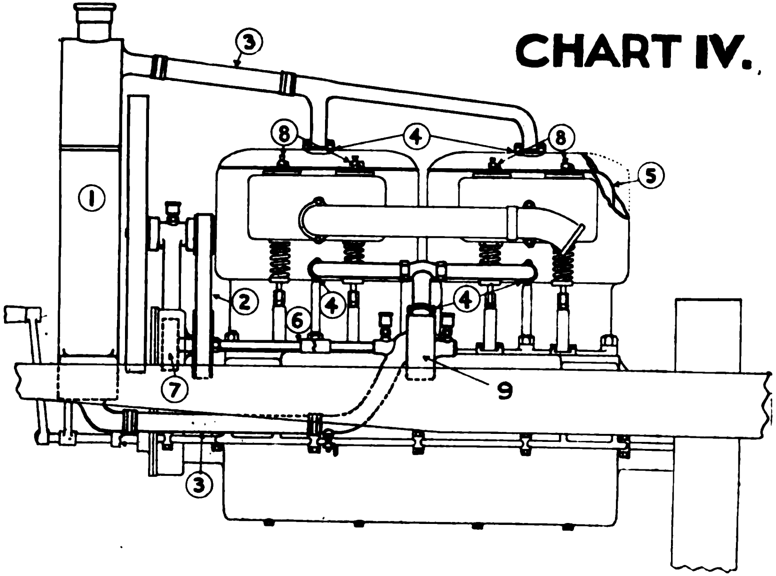


CHART IV.



ENGINE WILL NOT START

- **No Explosions**
  - No gasolene (I1)
  - Switch off or plug out (II1)
  - No pressure in gasolene tank (if pressure fed) (I2)
  - Batteries exhausted (II2)
  - Battery-to-switch wiring short-circuited (II3)
  - Switch out of order (II1)
  - Magneto short-circuited (if supposed to start on magneto)
  - Carbureter needs priming (I3)
  - Carbureter needle-valve closed (I4)
  - Gasolene pipe stopped up (I8)
  - Gasolene filter clogged or full of water (I5)
- **Occasional Explosions**
  - Carbureter flooded from too much priming (I3)
  - Carbureter needle valve too far open (I4)
  - Carbureter float water-logged (I13)
- **Engine Hard to Crank**
  - Pistons seized (III1)
  - Bearing seized (III7,8)
  - Pump frozen up (in cold weather) (IV9)
- **Engine Will Run a Few Minutes**
  - Vent hole in gasolene tank stopped up (if gravity-fed) (I6)
  - Pressure valve or pump out of order (if pressure-fed) (I7)
  - Leak in pressure pipe to tank (if pressure-fed) (I2)
  - Gasolene pipe partly stopped up (I8)
  - Batteries nearly exhausted (II2)

- **ENGINE RUNS IRREGULARLY**
  - **One or More Cylinders Miss Regularly**
    - Spark plugs sooted or insulation cracked (II6)
    - High-tension cables short-circuited (II7, 8)
    - Timer-to-coil wires short-circuited (II9)
    - Timer contacts worn or out of adjustment (II10)
    - Magneto distributor contacts worn or out of adjustment (II13)
    - Vibrators out of adjustment (II11)
    - Valve broken (III3)
    - Valve spring weak or broken (III4)
    - Leak in inlet manifold or around valve stem (I9)
  - **One or More Cylinders Miss Occasionally**
    - Batteries weak (II2)
    - Defective wiring which touches a metal part (II3, 7, 8, 9)
    - Timer loose or containing foreign matter (II10)
    - Magneto distributor containing foreign matter (II13)
  - **Will Not Run Slow**
    - Auxiliary air spring too weak (I12)
    - Use batteries instead of magneto
  - **Will Not Run Fast**
    - Auxiliary air spring too stiff (I12)
    - Carbureter needle valve too far closed (I4)
    - Vibrators too loose (II11)
    - Spark timing or throttle connections wrong
  - **One Pair of Cylinders Misses**
    - Leak in branch of inlet manifold (I11)
    - Magneto circuit-breaker out of order (II12)

ENGINE RUNS REGULARLY, BUT WITH LITTLE POWER

- **Engine Overheats**
  - No water in radiator (IV1)
  - Fan belt loose or broken, or pulleys loose (IV2)
  - Rubber hose clogged (IV3)
  - Gaskets swollen (IV4)
  - Radiator clogged up or covered with scale (IV1)
  - Cylinder walls covered with scale (IV5)
  - Pump shaft broken (IV6)
  - Pump driving pinion loose on shaft (IV7)
  - Pump wheel broken or loose on shaft (IV9)
  - Carbureter needle valve too wide open (I4)
  - No oil in tanks (III10)
  - Oil sight feeds closed down (III16)
  - No pressure on oil (if pressure-fed) (III11)
  - Oil pump or pumps inoperative (III13)
  - Oil pipes stopped up (III14)
  - Oiler drive shaft or belt broken or loose (III12)
- **Knocking Noise**
  - Carbon in cylinders causes preignition (III2)
  - Loose crankshaft bearing (III7)
  - Loose connecting-rod bearing (III8)
  - Stray nuts or other parts in crankcase (III9)
- **Weak Compression**
  - Wrong grade of cylinder oil (III10)
  - Cylinders scored (III1)
  - Piston rings scored or clogged or slots in line (III5)
  - Valves need regrinding (III6)
  - Compression cocks open (IV8)

INSTRUCTION OF COAST ARTILLERY CORPS, RHODE ISLAND NATIONAL GUARD

BY CAPTAIN ARTHUR P. S. HYDE, COAST ARTILLERY CORPS,
UNITED STATES ARMY

It is a generally recognized fact that in a war with an oversea power, our coast defenses must be in a state of preparedness at the very outbreak of the war, in order that they may prove effective as the first line of resistance. This condition requires that the defenses be manned by trained artillerymen, and permits no opportunity of organizing and training volunteer troops after war has been declared, to supplement the regular garrisons.

With a military policy such as ours, it is extremely doubtful if we will ever have an adequate regular army, and therefore it is our duty, both to ourselves as officers of the army, and to our country to take advantage of every opportunity given us to overcome the disadvantages of so indefinite and precarious a policy as we have followed in military matters, ever since we have been a nation.

Much as we may desire an adequate reserve into which men would be transferred upon completion of their enlistments, instead of discharging them, and thereby losing entire track of so many trained soldiers, we must nevertheless accept this as one phase of our national policy.

To supply this deficiency, the War Department is definitely committed to the policy of depending upon the Organized Militia of the various states, and as far as coast artillery reserves to supplement the regular garrisons of the various artillery districts are concerned, it seems a most admirable thing. The idea of home defense which is dear to the heart of every citizen soldier, has an especial significance to the coast artilleryman, for upon the outbreak of war, he is assigned to duty in one of the forts which protect the entrance to the harbor of his own home city. It would therefore seem that the coast artillery arm would appeal especially to members of the Organized Militia, resident in coast cities.

Again, many men who would gladly volunteer their services in time of war, but who for personal or family reasons of one sort or another, are unable to do so, can render effective service, at home, in the coast artillery reserves.

The War Department having adopted this policy, it is of the greatest importance that the coast artillery reserves of the different states be brought, in time of peace, to that degree of efficiency whereby they can handle the ordinary elements of artillery defense, without assistance, so that they may be able to man their respective batteries upon the outbreak of war, without the necessity for the regular troops to act as instructors, at a time when the latter will have all they can attend to in making their own preparations for defense.

To accomplish this, it is essential, first, that the reserve officers be well instructed in at least the practical part of our profession, and as much of the theoretical as they may individually be capable and desirous of acquiring. Secondly, that each reserve company have a thoroughly trained fire control section, able to go into a station and operate the various instruments without delay or further instruction. And thirdly, gun commanders, gun pointers, range and azimuth setters, and mechanics, who are proficient in their respective duties.

The coast artillery reserve companies of all the states are probably inadequate in size for war service, and would therefore have to be recruited up from more or less untrained men; but a fire control section is no larger in war than in peace, nor are any more gun commanders, gun pointers, range and azimuth setters, nor mechanics, required. Therefore if these important positions are filled with men who have had ample training in time of peace, and the men of the company generally instructed in these important duties, it will be a comparatively simple matter to break in recruits for those positions in the gun and ammunition sections, which require less brain than brawn.

The writer has had two years experience with the armory instruction of the coast artillery reserves of the state of Rhode Island, and in addition, has acted as instructor during combined coast defense and militia exercises, of the coast artillery reserves of New York, Connecticut and Rhode Island, during eight camps, last summer being detailed by the Department Commander as Inspector-Instructor, during the exercises of the Rhode Island troops.

Having made a careful study of the whole situation, he believes that this article descriptive of the work done during the past two years in Rhode Island, will be interesting to coast artillery officers as illustrating what has been accomplished, and the methods followed, and also may prove helpful to others who are undertaking similar work elsewhere.

In January, 1909, a letter from Headquarters Department of the East to the Commanding Officer, Artillery District of Narragansett Bay, informed the latter that the Coast Artillery Corps of Rhode Island was to be considered as a part of the personnel of that district, and directing him to detail an officer as Instructor of Coast Artillery Reserves. In accordance with this letter, the writer was detailed by a district order, and the method of the instruction to be imparted, placed entirely in his hands.

The Coast Artillery Corps of Rhode Island consists of sixteen companies, organized for administrative purposes in two districts of eight companies each, each district having a complete field and staff organization. There are therefore two colonels, two lieutenant-colonels, four majors, twenty-four captains, twenty first lieutenants and twenty second lieutenants.

Five companies of each district are located in Providence, one of each district in Pawtucket, one of each district in Woonsocket, one of the First District in Westerly, and one of the Second District in Riverpoint.

After consultation with the state authorities, it was decided to begin theoretical instruction of the officers at once, and at the same time, start work in preparing such material as could be improvised for practical instruction.

In accordance with this plan an officers' school, which met in the state armory in Providence, weekly, was immediately inaugurated, the instruction for the most part being by lecture.

The course was based upon the suggestions contained in Circular No. 21, War Department, 1908, and included the following subjects, viz.:—

a. The general principles of coast defense, with special application to the conditions obtaining in Narragansett Bay.
b. The artillery defense, including tactical organization.
c. Tactical uses of guns and mortars.
d. Gun construction.
e. The 12-inch disappearing carriage.
f. The mortar carriage.
g. Explosives.
h. Fuzes, primers and projectiles.
i. Fire control system including the principles involved.

Two double base-end stations were erected in opposite corners of the armory and made as nearly like the type stations as possible. A scale was assumed for the armory as 1 inch equal 30 yards.

It is the intention of the War Department to eventually equip each large armory with a dummy 10-inch disappearing gun, a dummy 12-inch mortar, and a dummy rapid fire gun, all of full size, for practical instruction of gun sections, and subcaliber practice. The pintle centers of these were therefore located on the armory floor, and the latitude and departure of each of the first two determined with reference to its own primary station. We thus had simulated, a heavy gun battery, a mortar battery, and a rapid fire battery.

The original plan called for a fire commander's station in the east balcony, to be equipped with an azimuth instrument, a time interval bell, and telephones connecting with the battery primaries, the rapid fire battery, and a meteorological station to be established in one of the towers of the armory. Upon learning that the War Department intended supplying the full standard equipment for this station, including a fire commander's plotting board, it became necessary to modify this plan, and pending the receipt of the material, the fire commander's station was held in abeyance.

House type phones, equipped with head receivers and breast transmitters, were purchased by the state, and installed in the stations in accordance with the requirements of the fire control system.

Communication was thus obtained between the plotting room and the primary and secondary stations, the plotting room and the gun, and the primary station and the battery commander, of each battery. Provision was also made for communications to the fire commander's station whenever it should be erected. The gun phones and battery commanders' phones were placed in boxes on the armory wall in rear of the pintle centers marking the future location of the gun and mortar. It was thus possible to keep these telephone operators in training, as well as those employed in the plotting room and observing stations.

The time interval system consisted of three-inch single stroke gongs in all the observing stations, and five-inch gongs at the batteries, all on the same circuit. It being impracticable to obtain a time interval clock, a strap key was placed in the circuit, and it was operated by a man equipped with a watch having a second hand. Except for being a monotonous duty for the operator, the scheme worked admirably.

For observing instruments, two obsolete Keuffel and Esser azimuth instruments were obtained upon authority of the Department Commander on memorandum receipt from the district ordnance officer, and mounted in the stations of the gun battery. To avoid the extremely awkward method of reading, inherent in this instrument, a horizontal brass plate was clamped to the foot of the yoke, 90° to the left of the original vernier, and on this, a paper vernier pasted, so graduated that forty-nine divisions corresponded to fifty divisions of the limb. It was thus possible to read fractions of a degree in hundredths instead of seconds. It will be remembered that the least reading on the limb of these old instruments is one-half a degree. This arrangement also enabled the reader to stand in a convenient place, without interfering with the observer, the old vernier being directly beneath the eye-piece.

With five companies using the armory on a single night, it was necessary that there be no interference between the artillery and infantry drills, which made it undesirable to have a target on the floor. A light cable was therefore stretched obliquely across the west end of the armory about twelve feet above the floor, and rigged with a luff tackle at one end, so that it could be stretched taut. Hanging from this cable by ordinary galvanized awning pulleys, were two light frames covered with muslin, on each of which was pasted a large blue print of a battleship.

In constructing the tracing from which the blue prints were made, the full dimensions of a battleship 450 feet in length, were assumed at 6,000 yards, and then reduced proportionately to a range of 200 feet. This gave a silhouette five feet long, and thus appeared to an observer as of the same size as the real battleship, say of the *Connecticut* class, at an actual range of 6,000 yards. The targets were connected by a cord so that the distance from the stern of the leading ship to the bow of the rear one was ten feet, equivalent to 300 yards.

The targets were controlled by means of an endless cord passing over a drum placed at a convenient height above the floor, beneath one end of the cable. The diameter of the drum was so designed as to give a speed in miles per hour of the targets, equal to the number of revolutions per minute of the drum. Thus, if it were desired to give the targets a speed of fifteen miles per hour, the operator simply had to turn the crank fifteen times in a minute. By putting a sufficient number of turns of the "tow-line" around the drum, a very uniform speed could be given the targets. The drum was operated by man power.

Plotting, range and deflection boards and wind component indicators were improvised. The plotting board (Fig. 1) was of the same dimensions as the Whistler-Hearn board. A single azimuth circle was constructed near the outer edge of the board, on the diagonal vernier principle, with a least reading of 0°.10, but this could be halved with considerable degree of accuracy by the eye. Three arms were used in conformity with the standard boards, the auxiliary and secondary ones being permanently connected by a brass coupler.

It was impracticable to provide tally dials, except at heavy expense, which was not warranted as the board was for temporary use only. Therefore a small azimuth circle was constructed in rear of the main diameter, with the gun arm center as its center. It was also constructed on the diagonal vernier principle.

For each plotted position of the target, No. 3 would write down the gun arm azimuth. This he would subtract from the preceding, to give the angular travel during the observing interval. If the azimuth was increasing, he would add this result to the normal, 15; if decreasing, he would subtract it from 15. The reference number resulting, was then called to the deflection board operator. This not only proved a satisfactory arrangement, but was advantageous in showing the men practically what the tally dial reading is.

It was not deemed advisable to make a range correction device on the gun arm. A slide with a rack and pinion could readily have been applied, but the expense involved was prohibitive for a temporary board. The complete operation of the range board was gone through with regularly for the training of the operator, and the resulting range correction was *assumed* to be applied to the gun arm of the plotting board.

This board was made under the supervision of the instructor by Major Clarence H. Greene, C. E., and Captain Nolan, C. A. C., R. I. N. G. Work was also started on a mortar board of the same character, but the receipt of the standard board before its completion, caused the abandonment of it.

The range board consisted of a board of the necessary size on which was glued a 12-inch range board chart, obtained by making a tracing of a chart in use at one of the batteries in the district. The ruler was provided with a runner at each end, perpendicular to its length, which slid in a groove provided for it in the board. This was made to fit tightly enough to remain in any desired position, being held by friction. The metal parts were all made of sheet brass, appropriately stamped. This

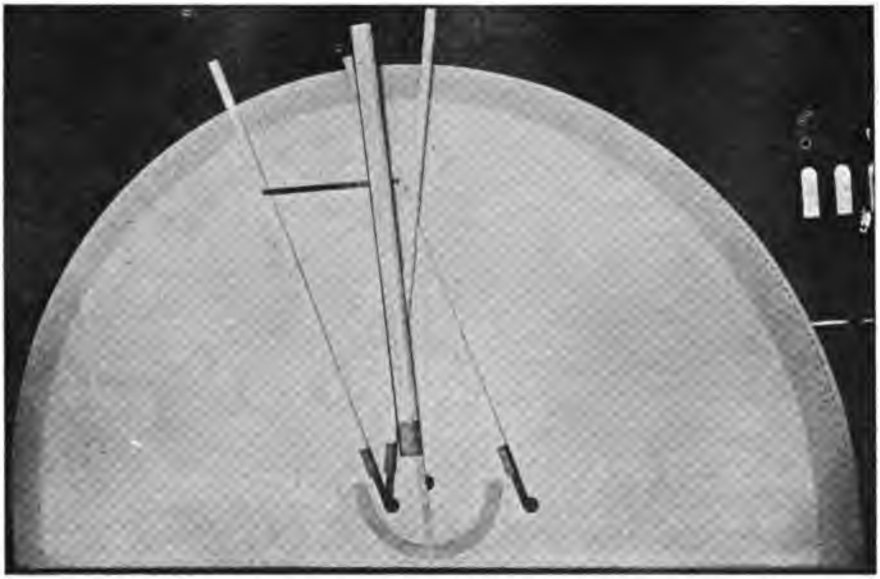


FIG. 1. IMPROVISED GUN PLOTTING BOARD

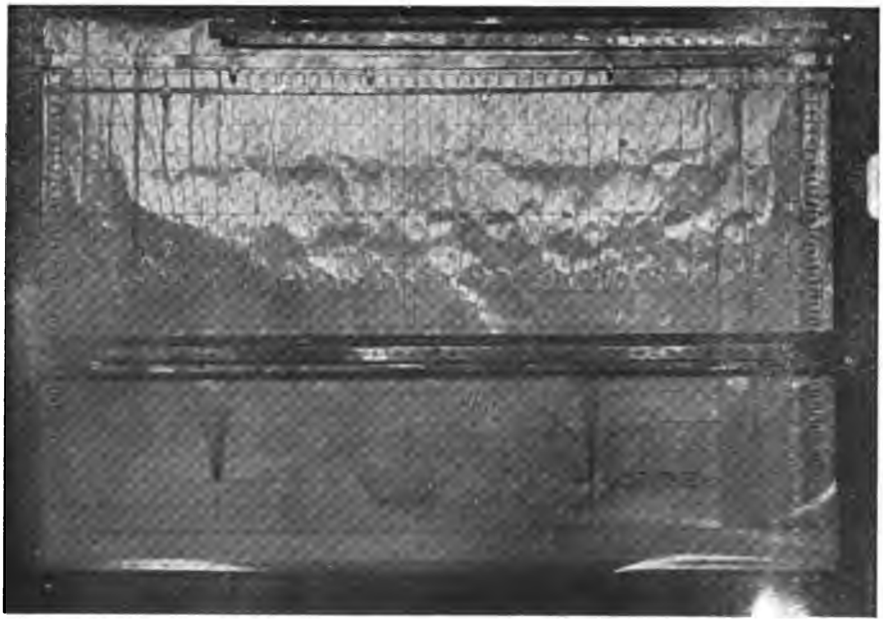


FIG. 2. IMPROVISED RANGE BOARD

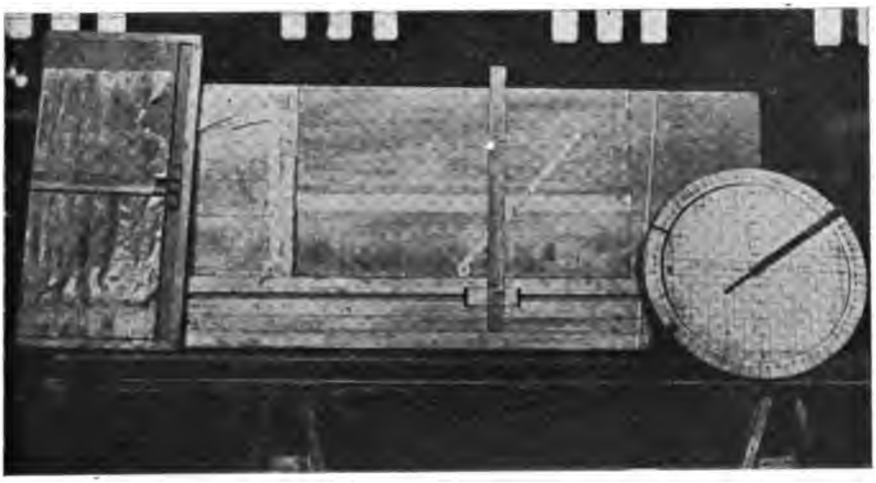


FIG. 3. IMPROVISED DEFLECTION BOARD, ATMOSPHERE BOARD AND WIND COMPONENT INDICATOR

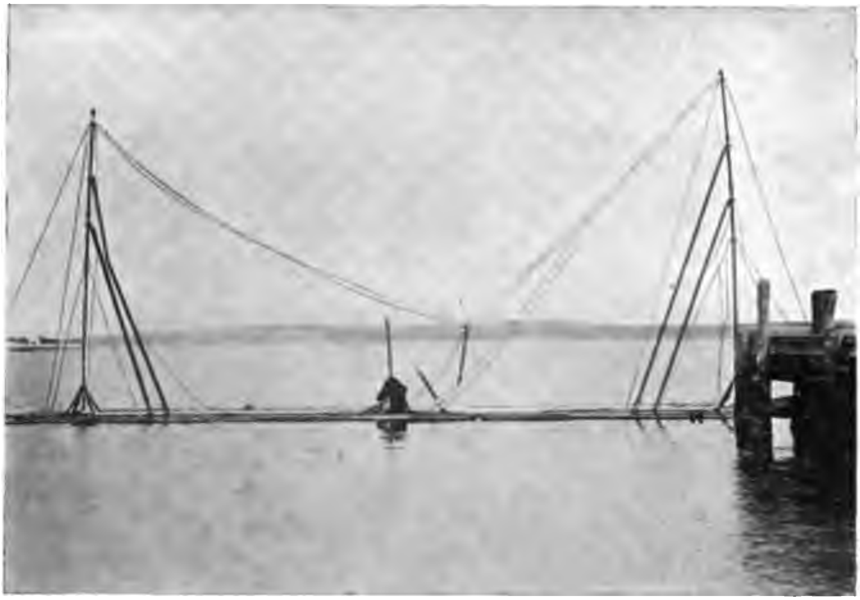


FIG. 4. MATERIAL TARGET AFTER SERVICE PRACTICE BY RHODE ISLAND COAST ARTILLERY RESERVES, JULY, 1910.

board was made by Corporal Joshua H. Bell, 130th Company, Coast Artillery Corps, and proved very satisfactory.

The illustration (Fig. 2) shows the *tracing* attached to the face of the board, as it was impossible to photograph the blue print chart satisfactorily.

The deflection board, atmosphere board, and wind component indicator, were made of wood, as nearly like the standard apparatus as practicable, and are shown in the accompanying illustration. (Fig. 3.) They worked very satisfactorily for drill and instruction. They were made by Sergeant Belk, 102nd Company, Coast Artillery Corps.

The armory instruction began October 1, 1909.

The standard fire control material began arriving in December 1909, and that intended for use in the Providence armory, was immediately installed. This included one Lewis depression position finder, model of 1907, one azimuth instrument, model of 1900 M^1, one Whistler-Hearn gun plotting board, one Pratt range board, one gun deflection board, one wind component indicator, one Whistler-Hearn mortar plotting board, one prediction and set forward device, and one mortar deflection board, the last named being borrowed from Battery Edgerton, Fort Adams. Additional azimuth instruments and a mortar deflection board were to be supplied when funds became available.

Complete gun battery fire control material, except observing instruments, was furnished for each of the small armories, but owing to the expense and time involved, it was impracticable for the instructor to make more than two trips a week, and it was thought best to confine the instruction to Providence, until such time as the companies there had reached a degree of efficiency that would enable them to conduct their drills alone.

Beginning January 1st, a course of instruction for officers, arranged by a board of officers of which Colonel Henry L. Harris, C. A. C., was president, was put into effect.

The following is an extract from the report of this board:

> "Officers of the coast artillery reserves should be the instructors of their men. In order to accomplish this purpose, these officers must qualify as instructors, so that the first efforts of the regular army instructor should be confined to the instruction of the commissioned officers."

The course prescribed covers three years, each year's work ending with an examination, and is as follows:

FIRST YEAR

1. Service of the piece.
    a. Duties of each member of the gun and ammunition section under all conditions.

2. Gun and carriage.
    - a. Nomenclature, purpose and action of the several parts.
    - b. Packing stuffing boxes and cleaning recoil cylinders.
    - c. Adjustment of quadrant elevation device, sight standard, throttling valve, gas check pad, elevating gear, grease cups, and firing mechanism.
    - d. Care and preservation.
3. Powders, projectiles, primers and fuzes.
    - a. Ventilation of magazines.
    - b. Blending powder and preparation of charges.
    - c. Filling and fuzing projectiles.
    - d. Painting projectiles.
    - e. Care of empty cartridge cases and primer bodies.
4. Cordage, gins, shears, jacks, and use of each.
5. Camp hygiene.

SECOND YEAR

1. Definitions of coast artillery drill regulations.
2. Fire control system.
    - a. Detailed knowledge of system employed at the battery.
    - b. Indication and identification of targets.
    - c. Duties of each member of the fire control section under all conditions.
    - d. Emergency system and salvo points.
3. Fire control apparatus.
    - a. A detailed knowledge of adjustment and use of all fire control apparatus.
4. Elementary gunnery.
    - a. Explanation of the several corrections to be applied to the observed range to obtain the corrected range.
    - b. Effect on the flight of projectiles of variations in the density of the air; the direction and velocity of the wind.
    - c. Use of trial shots and application of the data obtained from them.
5. Pointing.
    - a. Methods of pointing and pointing tests.
    - b. The telescopic sight; (the quadrant for mortars).
    - c. Bore sighting and orientation.
    - d. Emergency system and salvo points.

THIRD YEAR

1. General principles of coast defense.
2. Organization of coast artillery personnel and duties of separate commanders and manning bodies.
3. Role of guns of different calibers, and mortars.
4. An artillery inspection.
5. Characteristic features of the several classes of war ships, general knowledge of local shipping; of channels leading to the harbor; and of ranges to prominent fixed objects in the field of fire of the battery.
6. Conduct of subcaliber and service practice.

Ten weeks were allowed to the first year's course, one night being devoted to it each week. Except in cordage, the instruction was of necessity entirely by lecture, illustrated with diagrams on the blackboard, and supplemented by individual study of the drill regulations, the ordnance pamphlet descriptive of the carriage to which the officer was assigned, and the ARTILLERY JOURNAL'S pamphlet entitled "Gunners Instruction."

Two evenings were allowed for each of the following subjects, viz.: Service of the piece; guns and carriages; powders, projectiles, primers and fuzes; three evenings to practical instruction in cordage, etc.; and one evening to a lecture on camp hygiene.

Upon the recommendation of the instructor, the examination was postponed until after the conclusion of the next camp, in order to give the officers an opportunity for *practical* instruction in those subjects which could be covered only inadequately by lecture. The writer was transferred to a distant station the week following the conclusion of the camp, and is therefore unaware of the results of the examination.

Weekly drill of all the companies was continued throughout the season at the Providence armory. When a degree of proficiency had been attained that made it possible for the writer to reduce the number of trips to Providence, he went to each of the out of town armories, accompanied by Major Greene, and set up the fire control material provided for them, making this operation the subject of instruction for the officers and certain picked men of the companies concerned.

No azimuth instruments were available, so a track was made on the plotting board, and the corresponding azimuths determined and recorded. This gave a series of data with which drill could be held.

Lieutenants Saloman and England of the reserves, were detailed as additional instructors, and a schedule of visits made such that one of the six instructors would visit each company each week.

The combined coast defense and militia exercises in the Narragansett Bay district for 1910, afforded an opportunity of an unusual nature to test the information that had been acquired.

The writer had had experience the preceding year at Fort H. G. Wright, of trying to properly instruct reserve companies at a battery out of commission, with only one enlisted assistant, and realizing the very unsatisfactory results, recommended that one-half of the 117th Company go into camp at Battery Toussard, Fort Getty, and one-half of the 130th Company, at Battery Mitchell, Fort Greble, both of these batteries being out of commission. The other halves of these companies, were to encamp, as usual at the batteries to which they were regularly assigned. The further recommendation was made that the placing of Batteries Toussard and Mitchell in commission, with the location of temporary stations, measurement of base lines, etc., etc., be made a practical problem for a picked detail of officers and men of the reserves. This plan met with the hearty approval of the District Commander, and was ordered by the Department Commander.

Accordingly, a detail consisting of Major Clarence H. Greene, C. E., Captain Walter L. Anthony, First Lieutenant Davis C. Arnold, Master Gunner Robert I. Nisbet, and Electrician Sergeant (2nd Class) Bradbury Barnes, C. A. C., R. I. N. G., and four privates, were ordered to camp one week before the arrival of the National Guard troops.

Battery Toussard is a new battery, and never having been in commission, no fire control system had been installed. It was planned to establish a horizontal base across the channel, the secondary station being located at Fort Kearney on the west side. The telephones could be provided from the district, and all the rest of the fire control material was to be brought from the armory at Providence.

Battery Mitchell had never been placed in commission, and had no fire control equipment. One side of a new double mine primary station at that post, however, was not in use, and it was proposed to utilize it as a primary station and plotting room for this battery. The fire control material of the writer's design, as described in the ARTILLERY JOURNAL for May-June, 1910, was brought from the armory in Providence for use at the battery.

From July 12th to 16th, Major Greene, Captain Anthony and Master Gunner Nisbet prepared all the data necessary for placing the two batteries in commission, opened and equipped the stations pertaining to each, and when the reserves arrived at the post on July 17th, everything was in readiness for them. They went into camp in rear of their respective batteries.

The writer was detailed by the Department Commander as Inspector-Instructor at the exercises, and the following was the general scheme followed.

Owing to the small size of the companies, the maximum strength being sixty-three men, two are assigned to each battery. Each company, mortar as well as gun, has a complete fire control section. The company commanders each took their turn commanding the battery, each being on duty for one half of each drill period, and while each was on duty, his own range officer and fire control section was also on duty.

At a two gun battery each company supplied one gun and one ammunition section, with a lieutenant for emplacement officer, both guns being manned at once and for the whole drill period. Similarly in mortar batteries, each company was assigned to its own pit, although the strength was such that each could man only two mortars. At a three gun battery, one company manned No. 1 gun, and the other No. 3, a mixed section made up from both companies, manning No. 2.

Battery or fire command drills were held daily, and target practice at moving targets, daily, beginning on the second working day.

Each company fired its full allowance of both subcaliber and service ammunition, and the results on the whole were most satisfactory. The subcaliber targets were literally shot to pieces. No effort was made to count hits, but the practice was taken advantage of to train gun pointers and fire control sections, and also to give captains experience in making corrections based upon the observation of their own fire. All practice was at moving targets, and no trial shots were fired.

Service practice was held by the First District on Thursday and by the Second District on Friday, both at Fort Greble, as the guns at the other posts are not permitted to be fired. This practice was by company. For instance, the 6th Company fired four shots from their gun at battery Hale with their own fire control section on duty, and under the command of the captain of the 6th Company; then the 8th Company fired four shots from their gun, with their fire control section on duty, and the captain of the 8th Company in command.

In this way it was possible to encourage a healthy rivalry between companies. The palm was carried off by the 4th Company, Captain Wells, assisted, however, by the fire control section of the 3rd Company, Captain Buxton, as the former company was temporarily greatly reduced in strength. A score of 100% was made and a figure of merit of 94*, which is thought to be the finest record thus far made by reserve companies.

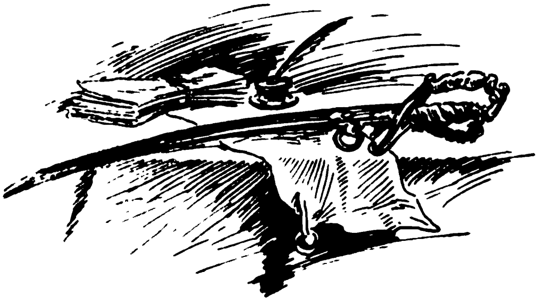
Perhaps the most satisfactory phase of the encampment, was the degree of independence which has been reached by these troops. Several times in making tours of inspection at the different posts, the writer went into stations during subcaliber practice, when there was not a regular officer nor enlisted man to be seen, and yet the work was running as smoothly as possible, and the target being hit shot after shot.

---

* The writer believes these figures to be correct, but has no means of verifying them at the present moment. The target practice reports were submitted in the usual way, and undoubtedly give the exact figures.

During the service practice at Battery Mitchell, the same condition obtained. In fact, at this battery, owing to the shortage of regular officers, Major Greene of the National Guard, was regularly assigned as instructor of the fire control sections. It is believed that this is the first time that such a proceeding has been possible.

It is the opinion of the writer that the target records would have been better, had each company been allowed one trial shot at a fixed target, and the balance as record shots at a moving target, but this would have taken a considerably longer time, and as all the firing with service charges was required to be at Greble, there was a grave possibility of not being able to complete the practice of all the companies.



COMPARATIVE COAL TESTS

[The following is a report of tests made by the Department of Enlisted Specialists, Coast Artillery School. The appendices mentioned in the report contain the details of the tests and are omitted herein, (except part of Appendix XI), the conclusions forming the report proper being all that is essential to an understanding of the results obtained. The part of Appendix XI, which is included here, gives recommendations for the future purchase of coal for the Coast Artillery School Power Plant.—EDITOR.]

Coast Artillery School,
Department of Enlisted Specialists,
December 1, 1910.

The Director,
Department of Enlisted Specialists,
Coast Artillery School,
Fort Monroe, Va.

Sir:—

I have the honor to submit the following report of comparative economy and evaporative tests of semi-bituminous and anthracite coals, made by the Department of Enlisted Specialists, at this School, under my direction, during the period from October 20th, 1910, to November 17th, 1910.

1. AUTHORITY FOR TESTS

These tests were made upon the request of this Department; and authority for the purchase of a car-load of semi-bituminous coal was given by the Quartermaster General of the Army, in 4th Indorsement from his office, dated September 14th, 1910. (Appendix I.)

2. PURPOSE OF THE TESTS

a. To determine the relative economy of the two classes of coal used in the Power Plant, Coast Artillery School, for the purpose of generating steam used in the production of heat, light, and power, for the post and school requirements, under variable conditions of demand upon the plant.

b. To determine the relative evaporative capacity of the two coals when used as fuel in the same boiler, under similar conditions of boiler operation.

c. To determine the degree of smokeless combustion of the semi-bituminous coal.

3. THE COALS USED

a. Semi-bituminous coal from Fayette County, West Virginia, supplied from the "Ballinger" mine, classified as "run of mine," and known by the trade name of "Orcutt's Smokeless New River Steam Coal." This coal is designated as "New River" hereafter in this report. The above mine is located on the Keeney's Creek branch of the Chesapeake & Ohio Railroad. A sample car of this coal was received at the plant on October 19th, 1910. Its condition was good, apparently free from excessive slate or dust and was claimed by the agents to be "a fair sample of the coal mined" at the above mine.

b. An anthracite coal from the Wilkesbarre District, Pennsylvania, chesnut size, mined by the Susquehanna Coal Company, and supplied for use in this plant by R. Hidden & Company, Baltimore, Maryland, under contract with the Chief Quartermaster, Department of the East (Appendix XI). This coal was part of a shipment of seven hundred and fifty tons (short), made in September, 1910, as a partial delivery under their contract for the fiscal year ending June 30th, 1911.

Samples of the New River and anthracite coals used in Tests 1, 3, 6, and 10, were sent to the Bureau of Mines, Department of the Interior, Washington, for analyses; the results being shown in Appendix II. The average of the two analyses of each kind of coal was used for the remaining tests.

4. METHOD OF CONDUCTING TESTS

All evaporative and working tests were made in accordance with the provisions of the Code for Conducting Steam Boiler Trials, as adopted by the American Society of Mechanical Engineers.

In the operation of the school power plant two Heine water-tube boilers, of 272 rated horsepower each, are used alternately; one of these boilers being of greater capacity than needed for peak load demand. It had been found by experiment that by reducing the grate surface a greater daily average economy was obtained. Hence these tests were made with the reduced grate areas. During the past year two such areas have been used; the smaller for about eight months and the larger for the remainder of the period. To obtain comparative data under the conditions stated in Par. 2 (a), six tests were made; and for obtaining data under the conditions stated in Par. 2 (b), four tests were made. The four latter tests were made to determine the comparative economy of the two coals when driving the boiler at its highest sustained capacity for not less than eleven hours, when using the grate surface in use for daily operation.

Great care was taken to obtain accurate results; the students in this department being utilized as observers, and operators. The same instruments were used throughout the series of tests in order to obtain a correct comparison. The degree of expertness in firing, however, was in favor of the anthracite coal, as it had been in use in the plant for the past year, and the firemen had not had experience with the New River coal. It was a matter of experiment on the part of the firemen to determine the proper method of firing the semi-bituminous coal during the working tests, in order to obtain the least amount of smoke. In making the smoke observations the Ringelmann charts were used. (See Appendix XXXV, Code of 1899, for Conducting Steam Boiler Trials.) The observers were detailed each day, during the use of the New River coal, to observe the density of smoke as indicated by the charts. Minute observations were made, and plotted as in Figs. 5 and 6, Appendix VIII.

5. The Tests Made

ECONOMY TESTS

Test No. 2. A 72-hour, working test, New River coal, with smaller grate surface, with no heating of buildings, engines run condensing, and steam utilized solely for electric power production. Coal weighed as used; and water weighed in measuring tank. Observations of steam and draft pressures taken hourly. Smoke observations taken each minute during eight hours of each day. Results of test given in Appendix IV.

Test No. 9. A 72-hour, working test, made under same conditions as Test No. 2, as to boiler operation, grate surface, and observation of data. Results given in Appendix IV. Anthracite coal used.

Test No. 4. A 72-hour, working test, with New River coal, using larger grate surface, a greater daily load, and running non-condensing, exhaust steam for heating, for 9½ hours during each day. Condensing during remainder of each 24 hours. Coal weighed, and water remeasured. Hourly observations taken of steam and draft pressures. Same boiler as used in Test No. 2. Results of test given in Appendix VI.

Test No. 7. A 72-hour working test, using anthracite coal, using same boiler and grate surface as Test No. 4, to obtain comparative data with Test No. 4. Results given in Appendix VI.

CAPACITY TESTS

Test No. 1. A 12-hour test, using New River coal, with smaller grate surface, to obtain the economy of evaporation when driving the boiler at its highest sustained capacity. Coal and water weighed. 15-minute observations of all other data. Results given in Appendix III.

Test No. 10. An 11-hour test, using anthracite coal, with smaller grate surface, to obtain comparative data with Test No. 1. Same conditions as Test No. 1. See Appendix III.

Test No. 3. A 12-hour test, with New River coal, using the larger grate surface; capacity test; 15-minute observations. Results of test given in Appendix V.

Test No. 6. An 11-hour test, using anthracite coal, for comparison with Test No. 3; using same boiler and same grate area. Same conditions of observation, and operation. Results given in Appendix V.

Test No. 5. A test for one hour, with New River coal, for the purpose of determining capacity of one boiler, using working grate area, to supply load requirement to furnish power for fortifications during night drill. In this test the boiler in operation was used, and rheostat load thrown on generators. Water measured and corrected for height in boiler at beginning and end of test. Results given in Appendix VII.

Test No. 8. Similar test as No. 5, using anthracite coal, with same conditions. Boiler was driven to highest capacity obtainable with working grate surface, using rheostat load. Results given in Appendix VII.

All tests made were with same conditions of heating and grate surface, as stated, and hand fired in each case.

6. Results of Tests

A. ECONOMY

The economic results of the four tests (Nos. 2, 9, 4 and 7) of 72 hours each, made under normal working conditions, averaged for each of the two tests with same coal, are:

1.	Coal	New River	Anthracite
2.	Evaporation from and at 212° F. per pound of coal fired, lbs.	10.82	10.00
3.	Average daily horsepower hours required under test conditions	2550	2550

4.	Daily cost of coal	$10.57	$24.07
5.	Yearly cost per horsepower,* (8760 hours)	$36.32	$82.67
6.	Pounds of coal fired per horsepower hour	3.19	3.63
7.	Pounds of coal fired per kw-hour*	6.04	6.50
8.	Percentage of ash and refuse	9.00	19.00
9.	Cost per kw-hour, cents	0.79	1.69

It will be noted (Appendix IV and VI) that the New River coal has 13.9 per cent. greater heating value by analysis; and that but eight per cent. was obtained in these tests. This fact shows that the firemen were not familiar with the New River coal, and that after some experience with this coal a greater economy with the New River coal will be shown.

B. CAPACITY

The results of the four tests for capacity (Nos. 1, 10, 3 and 6) showing the comparative economy of the two coals, are:

Coal	New River	Anthracite
Horsepower developed	287	175
Coal per horsepower hour, lbs.	3.48	4.2
Percentage of ash and refuse in coal fired	7.3	21.3
Evaporation, from and at 212° F. per pound of coal fired, lbs.	9.91	8.0
Comparative capacity	164	100
Comparative economy	124	100

The above results show: (1) a greater capacity developed when using the New River coal in the same boiler and same grate surface; (2) a greater economy when producing this increased capacity; and (3) a decreased percentage of ash with the New River coal, and an increased percentage of ash in the anthracite coal. It will be noted that while the relative heating values of the two coals, by calorimetric determination, is 113.9 for the New River, and 100 for the anthracite, the actual test heating value, during these capacity tests, was 124 for the New River and 100 for the anthracite. This indicates that the influence of the greater percentage of ash in the latter coal is threefold, (a) a greater amount of unconsumed carbon is unavoidably lost

---

* Throughout this report the term "horsepower" refers to *boiler* horsepower, and the term "kw-hr." refers to switchboard output in kilowatts per hour.

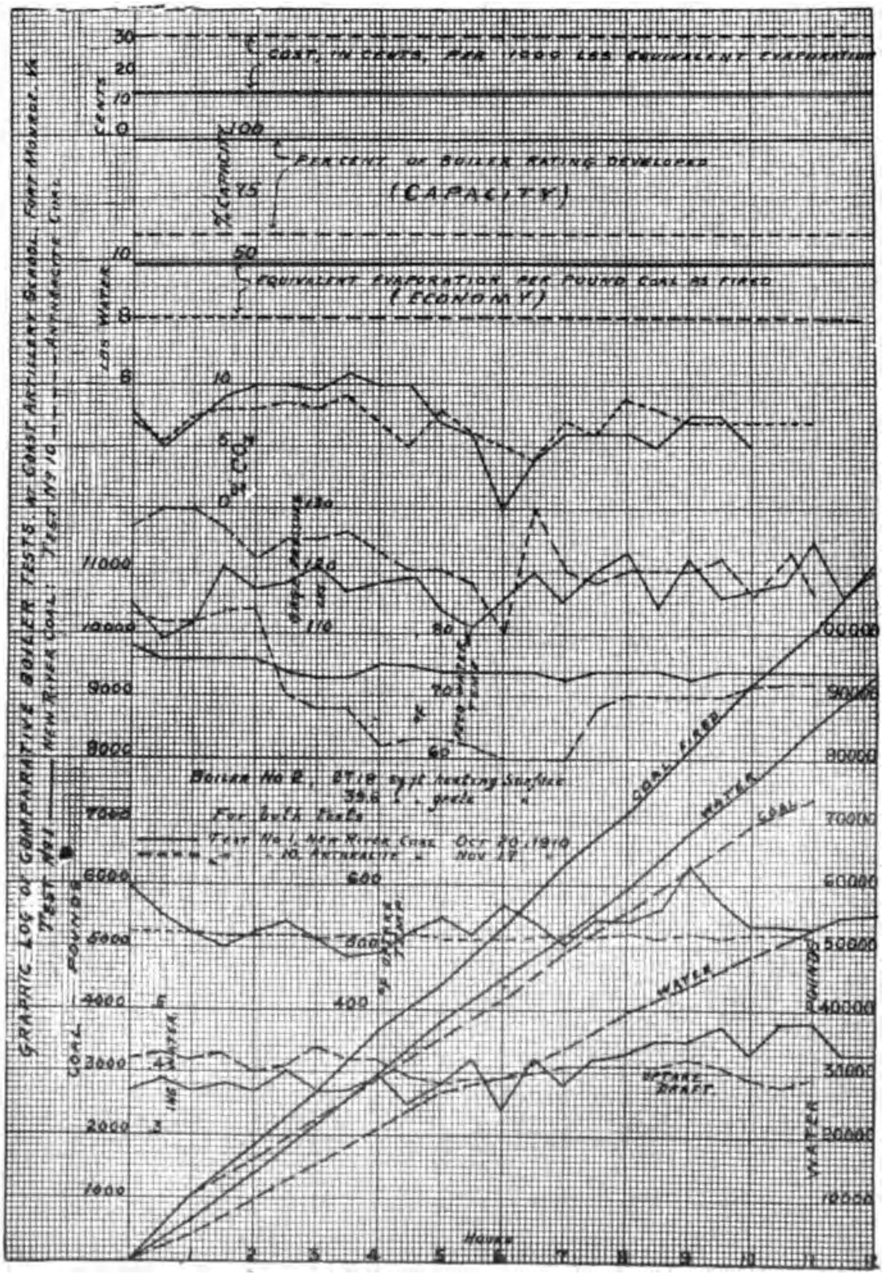


FIG. 1. GRAPHIC LOG OF COMPARATIVE BOILER TESTS FOR CAPACITY, COAST ARTILLERY SCHOOL, 1910.

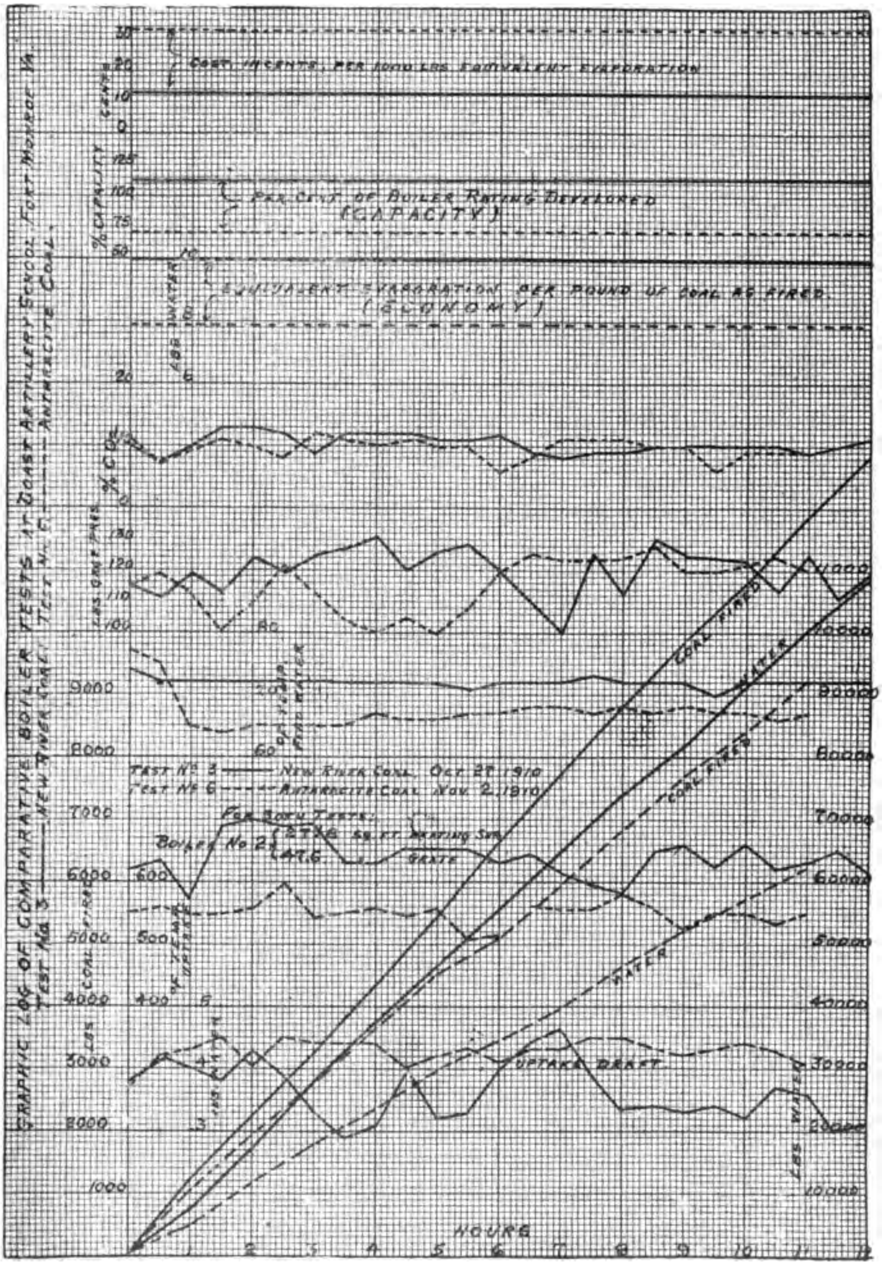


FIG. 2. GRAPHIC LOG OF COMPARATIVE BOILER TESTS FOR CAPACITY, COAST ARTILLERY SCHOOL, 1910.

because of the necessity for frequent cleaning of the fires with high ash coal; (b) the direct loss of heat by removal of the ashes; and (c) the clogging of the grate which prevents free combustion. Therefore, in the use of these two coals in this plant, on working grates, when peak loads are thrown on the steam generators, a much greater loss results in the use of the coal with the higher percentage of ash. In addition, the increased cost of ash removal and increased depreciation of boiler setting and grate, resulting from the use of high ash coal, is a factor of the cost of production.

The results of the two tests (Nos. 5 and 8—see Appendix VII) made to determine the capacity of the two coals for supplying power for the fortification night drills are as follows:

Coal	New River	Anthracite
Kilowatts required for power and lighting post during night drill for one hour	300	300
Horsepower, boiler, required	330	330
Horsepower, boiler, developed	330	220
Number of boilers used	1	1
Kilowatts output	313	193
Pounds of coal fired per H.P. hour	3.0	4.5
Pounds of coal fired per K.W. hour	3.2	3.1
Comparative capacity	150	100
Comparative economy	149	100

In making these two fortification load tests, the same boiler and grate surface was used; the same engines and generators; and the same conditions obtained. The test was made at the time in the evening when fortification load would be required for the night drills, and at a time when the peak lighting load was also required for the post. The fireman was notified but a short time before the test, and while the greatest lighting load was then on the boiler. It will be seen from the above results that the one boiler would not produce the required load when using the anthracite coal; but that the New River coal gave the required capacity. It would be necessary, therefore, in order to supply the boiler horsepower required for night drill load in addition to post lighting requirement, to put an additional boiler in service if the anthracite coal is used as fuel. This condition would require the firing of the additional boiler, and the capacity of approximately 165 H.P. each. To raise steam in the cold boiler would require 1200 lbs. coal; and the hour's run of the two boilers in parallel, at 165 H.P. each, would require 4.2 lbs. per H.P. (see Appendix III), or a total of 2586 pounds of anthracite coal. To operate one boiler, when under peak load, and using New River coal, would require 1000 lbs.

C. SMOKE OBSERVATIONS TO DETERMINE THE DEGREE OF SMOKELESS COMBUSTION

The results of the observations as to density of smoke produced by the burning of the New River coal is shown in Figs. 1 to 7, Appendix VIII. The observations were plotted by the observers each minute, as shown in Figs. 5 and 6, Appendix VII. From these plottings the average number of minutes per hour during which the smoke was of certain density, as determined by comparison with the Ringelmann chart (see Fig. 9, Appendix VIII), was obtained, and again plotted, as shown in Figs. 1, 2, 3, and 4, same appendix, by adding to the number of minutes of any density the number of minutes during which a higher density was observed. Thus, for Test No. 2 (October 22, 23, and 24), as shown in Fig. 1, during the first day of the test the average density of the smoke in minutes per hour was 12.75 minutes for No. 3 chart, *or greater*, and for the average of the three days observations, smoke of a density of No. 3 chart, or greater, appeared for 8.25 minutes per hour. In Fig. 3 is given the comparative density of the smoke produced by the School Plant and the Hotel Chamberlin power plant. This latter plant has been using the New River coal for some years. During the three days' observations of the smoke from these two plants, the engineer in charge of the Chamberlin was notified that such observations were being made; and hence the same degree of fairness to each plant was obtained. It will be noted that the density of the smoke from the School plant was 3.5 minutes per hour for No. 3 density, or greater, while the Chamberlin plant produced No. 3 smoke, or greater, for 11.25 minutes per hour, as an average of three days' observations. The location of the School plant, the Chamberlin plant, the wharf, mine planter, locomotive sheds, Sherwood Hotel, Chesapeake & Ohio R. R. station, are all shown on map (Fig. 8, Appendix VIII). All except the School plant are using bituminous coal. It should be noted that the amount of smoke produced by the School plant, as the tests progressed decreased in density (see Figs. 5 and 6); and that while the firemen had not been familiar with the burning of this coal, during the short time it was under test a marked increase in proper combustion, so far as smoke was concerned, was obtained. After a longer use of the New River coal, the firemen in this plant should not produce even as much smoke as appeared during the last few days of the test. The smoke ordinances of some of the larger cities of the United States are given in Appendix VIII, wherein it will be noted that while in some cities no degree of density is defined other than "dense black or gray smoke," in the most modern ordinances a certain density is indicated as being allowable. Referring to Fig. 2, Appendix VIII, it is seen that during the last working test of the New River coal the number of minutes of No. 3 smoke, or greater, was 5.25, as an average of the three day's observations. This density would be permitted under the city smoke ordinances. Fig. 7 is given as a photographic calibration, made during the observations of the School stack; which shows appearance of the smoke, as indicated by the different gradations of density of the Ringelmann charts.

7. RELATIVE ECONOMY OF THE COALS TESTED

As the cost of producing a given amount of steam is the ultimate criterion by which the efficiency of any fuel must be judged from an operative standpoint, the factors entering into the production cost must be considered. These are: (a) interest and depreciation of the steam generators; (b) repairs; (c) cost of water; (d) labor; (e) ash removal; and (f) the first cost of the fuel used. For the purpose of these tests, which were made to determine the relative efficiency of these two coals when used in this power plant, (c) and (d) need not be considered, as they are assumed to be constant. And while the difference in yearly depreciation and repairs to the boiler and grates and setting will amount to a small sum in favor of the New River coal, due to the fact that double the amount of cleaning fires would be required when using the anthracite coal, this item is also eliminated from consideration herein. The cost of steam production, then, depends upon items (e) and (f).

The estimated switchboard output of the plant for the year ending December 31st, 1911, is given in Tables I to VI, Appendix IX. Also the output, (electric) of the plant is given for the first eleven months of 1910, and estimated for December, 1910. On these estimates are based the following tables of comparative cost for fuel, using the two coals, and also the comparative cost for ash removal, based on test percentage of ash and refuse obtained. The fuel consumption per kilowatt hour in these tables (Appendix IX) includes fuel for all purposes, *i.e.* light, heat, live steam for laboratory, and electrical power for laboratory use.

The cost of cartage of ashes, and the cost of operating the pneumatic ash conveyor, now being installed, is shown in Appendix X.

TABLE I.

Comparative Cost of Ash Removal for 1911

Coal	New River	Anthracite
Cartage from plant	$112.34	$224.68
Operating ash conveyor	54.75	109.50
Total	$167.09	$334.18

Referring to the results obtained in the working tests (Nos. 2, 9, 4 and 7—Appendix IV and VI), it will be seen that but 92.8 per cent. of New River coal is required to produce the same boiler horsepower hours, compared to 100 per cent. for the anthracite coal, by weight. Therefore, but 92.8 per cent. of the estimated quantity of anthracite coal for the year 1911 is required, if the New River coal is furnished. The following table of comparative coal cost is based on the present price of New River and anthracite coals:

TABLE II.

Coal	New River	Anthracite
Pounds required, exclusive of night drills	3,157,030	3,401,972
Cost of coal per 2000 lbs.	$2.60	$5.20
Total cost for year, exclusive of night drill power	$4104.14	$8845.13

The following table shows the comparative cost of coal for the required power for fortification purposes during night drills:

TABLE III.

Coal	New River	Anthracite
Pounds coal required	45,000	112,500
Cost per 2,000 lbs.	$2.60	$5.20
Total cost	$58.50	$292.50

The following table gives the comparative cost of fuel for all purposes, including night drills, at different prices per short ton of 2,000 lbs. for the New River coal, the savings resulting from the use of the latter coal; together with total savings, including cost of ash removal, for 1911:

TABLE IV.

Cost of N. R. coal per 2000 lbs., $	2.60	2.70	2.80	2.90	3.00
Coal cost:					
Anthracite, $	9137.63	9137.63	9137.63	9137.63	9137.63
New River, $	4162.64	4322.74	4482.84	4642.94	4803.04
Saving, fuel, $	4974.99	4814.89	4654.79	4494.69	4334.59
Ash removal, saving, $	167.09	167.09	167.09	167.09	167.09
Total saving, $	5142.08	4981.98	4821.88	4661.78	4501.68

8. CONCLUSIONS AND RECOMMENDATIONS

From the foregoing report, and an examination of the appendices thereto, it will be seen that the saving which will be obtained by the use of a quality of coal equal to the New River coal tested, at a price below three dollars per short ton, instead of the present anthracite coal, will be more than half of the cost of anthracite fuel for this plant. It will be noted, also, that the density of smoke produced by the burning of the New River coal is below the permissible density prescribed by city ordinances. In view of the fact that all Quartermaster boats, the U. S. Army Mine Planter, the two hotels, the locomotives of the Chesapeake & Ohio Railroad, and of the Quartermaster's Department on this post, as well as all steam vessels landing at the post wharf, are all producing a considerable quantity of smoke each day, it seems that there should be no objection to the Government deriving the benefit of the great saving resulting from the use of a high grade of semi-bituminous coal, when the additional smoke would be so slight as to be unnoticeable. It is therefore recommended that this power plant be supplied with a quality of coal equal to that of the New River coal just tested.

In concluding this report, attention is invited to a proposed method of purchasing coal for this power plant. The purpose of burning coal under boilers is to abstract the heat for useful purposes. Hence a method of purchase which does not prescribe the ingredients of the fuel must result in a loss to the consumer. Commercial consumers of coal have long since adopted this method in the purchase of fuel for power production. It needs no further argument than these tests to show that all coals are not of the same value as to heat content. The quality of coal varies from time to time, even from the same mine. Therefore, a continuous sampling must be had, and analytical tests made, to determine whether this quality is uniform. The purchase of coal on a definite specification, both as to its chemical composition, and its thermal value, as measured in British thermal units, is both just and advantageous to the contractor and the consumer alike. By requiring the bidder to specify the quality of the fuel he proposes to furnish to the government at a given price, it establishes a standard of quality, any deviation from which can be easily adjusted by means of a scale of price for quality above or below the contractor's specified standard.

It is therefore recommended that future purchases of coal for this power plant be made under specifications embodying the features outlined in Appendix XI.

Very respectfully,
OFFNERE HOPE,
1st Lieutenant, Coast Artillery Corps,
Instructor, In charge of plant.

APPENDIX XI.

* * * * * *

PROPOSED METHOD OF PURCHASING COAL FOR THE USE OF THE POWER PLANT, COAST ARTILLERY SCHOOL, FORT MONROE, VIRGINIA*

1. In awarding contract for the supply of coal for the use of the Coast Artillery School Power Plant, consideration will be given to the quality of the coal, expressed in percentage of ash in "dry coal" (dry coal being determined by drying a sample at a temperature of 105° and 110° Centigrade for a period of time sufficient to obtain constant weight after two successive weighings); the percentage of sulphur; and the number of British thermal units in one pound of "coal as received"; as determined by bomb calorimeter.

Bidder to state in his proposals the above percentages, and the number of B.t.u. per pound in the coal offered, to be known as the "contractor's standard."

2. Quantity as contracted for may be increased or decreased to the extent of twenty (20) per cent. To be delivered at such

---

* Since this report was submitted, the Quartermaster General of the Army has issued specifications embodying the features herein proposed for the purchase of all coal used during the fiscal year beginning July 1st, 1911, at army stations within the United States.—EDITOR.

times, and in such quantities as the Government may direct. Upon delivery of any lot the coal will be weighed by a representative of the United States, and payment based upon Government weights as received.

3. Upon the receipt of any partial shipment under such contract for the supply of coal, representative samples shall be taken by a representative of the Government. Such sample to be not less than one hundred pounds, selected proportionately from the lumps and fine coal, and from different portions of the lot, or cargo, delivered, so that a true sample of the whole partial delivery may be obtained.

This one hundred pound sample shall be crushed as rapidly as possible in order to retain its moisture, until none of the fragments exceed one-half inch in diameter. The sample will then be divided and quartered, opposite quarters being thrown out; the remaining portions being thoroughly mixed, again quartered, and opposite quarters thrown out as before. This process to be repeated until a final sample is obtained sufficient to fill a two-pound can or jar. The sampling will be made in the presence of the contractor, or his representative, if requested. The sample obtained shall be sealed, and securely wrapped, and forwarded to the Director, Bureau of Mines, Department of the Interior, Washington, D. C., where it will be analyzed and tested by the method adopted by the American Chemical Society, and by the use of a bomb calorimeter.

4. Coal known as semi-bituminous, run of mine, free from excessive slate, bone, dirt or dust, is desired. Coal containing ash in excess of seven (7) per cent., sulphur in excess of two (2) per cent., or volatile matter in excess of twenty-five (25) per cent. will not be considered. Such coal to be delivered at Fort Monroe, Virginia, and properly piled in coal bins, bunkers, woodyard, or other place of storage within the limits of the reservation, as the receiving officer may direct. A contract entered into under the terms of these specifications will not be binding, if, as the result of practical test, under service conditions, the coal fails to give satisfactory results, due to its non-coking character, to excessive clinkering, or to a prohibitive amount of smoke, or to any other cause which make it an undesirable fuel. It is understood that the coal delivered during the period of such contract will be of a character specified by the contractor in his proposal; and should therefore be supplied from the same mine or group of mines. Occasional deliveries of coal containing ash up to the limit above specified may be accepted; but frequent, or con-

tinued, failure to maintain the contractor's standard will be cause for cancellation of such contract.

5. Payment for coal which has been delivered and used, of which remains on the government reservation at the time its quality is determined, will be made at a price computed under the following terms:

Upon the receipt by the receiving officer, and his certificate of such receipt, specifying the weights so received; and that samples have been procured and forwarded to the Bureau of Mines, as above specified, for analysis; and upon receipt of such certified analysis of the sample from the Bureau of Mines, payment will be made for such delivery, to the extent of ninety (90) per cent. of the computed value of such quantity delivered; the retained ten (10) per cent. to be paid to the contractor on final settlement of his contract, or not later than three months after receipt of certified analysis from the Bureau of Mines, of the sample taken from such delivery.

Payments will be made at the price named in the contract for the standard value of the coal as contained in the bidder's proposal; and corrections for variations from such standard values of heat and ash value above or below the standard will be made as follows:

Ash.—For all coal under such contract, containing a greater percentage of ash than the contractor's standard, a deduction at the rate of two (2) cents per ton for each per cent. of ash up to ten (10) per cent. For each per cent. of ash above ten (10 per cent. and not over twelve (12) per cent. an additional deduction of ten (10) cents per ton; and for each per cent. of ash over twelve (12) per cent. an additional deduction of twenty (20) cents per ton.

For each per cent. of ash below the contractor's standard, an additional price of two (2) cents per ton.

Heat value in British thermal units.—The corrections in price for variations in heat units from that specified in the contractor's proposal, and made part of his contract, shall be made as determined by the following formula.

$$\frac{\text{Delivered B. t. u.}}{\text{Standard B. t. u.}} \times \text{contract price} = \text{price to be paid.}$$

6. The bunker capacity at this plant is approximately ninety (90) tons; and quantities will be desired in lots of not more than two (2) car-loads of forty to fifty tons each.

The value of a ton under the above specifications is understood to be 2,240 pounds.

PROFESSIONAL NOTES

VICKERS' ORDNANCE AT THE JAPAN-BRITISH EXHIBITION

If the primary function of an exhibition, apart from its recreative utility, be educational, it will be conceded by the visitor to the Japan-British Exhibition that the Vickers display of ordnance achieves high success. There is here demonstrated within easy compass a complete record of recent developments in naval and field artillery, in association with an object lesson on the methods adopted to ensure high power with that lightness which is important in order to minimise the displacement of ships, on the one hand, and to increase the mobility of a field force, on the other. In respect of the latter it is interesting, for instance, to note the progress made with field artillery by one or two outstanding features in the exhibit. The automatic rifle-caliber gun has recently been reconstructed, and it has been possible to reduce the weight of the gun from 60 lb. to 26 lb. This has been done by introducing a corrugated water-jacket, and by replacing all gun-metal by high-grade steel in the construction of the mechanism generally. The action is entirely automatic, the gun being fed with cartridges from a belt, and the firing is controlled at will by pressure applied to the trigger lever in the rear. The Vickers mitrailleuse was originally mounted either on a carriage or tripod; but there has been adapted for it a tripod of an adjustable type which enables the gun to be raised or lowered by means of a handle, to suit any available "cover", without altering the elevation of the gun; the height from the ground may vary from 16 in., the lowest position, to 33 in., the highest position. The weight of the mounting is 34 lb., so that the total weight of gun and mounting only amounts to 60 lb., which compares very favorably with the service gun, the weight of which is 60 lb., while the weight of their tripods varies from 47 lb. to 84 lb.

The 37-mm. gun can fire 1 lb. shot at the rate of 300 rounds per minute with a muzzle energy of 22.5 foot-tons. The total weight of gun and mounting is 7.75 cwt. The 75-mm. mountain gun has always been an attractive feature at exhibitions, as the gun can fire seven 12½ lb. rounds per minute at a muzzle velocity of 920 ft. per second = to 73.4 foot-tons of muzzle energy, and yet its weight of 8 cwt. can be loaded on four mules, one carrying the gun, 296 lb.; a second the cradle, 288 lb.; a third the wheels, 277 lb.; and a fourth the trail, 278 lb., with others each taking 288 lb. of ammunition.

Interest also attaches to the 12½-pounder semi-automatic gun, the ballistics of which are given in Table I., and the weights, &c., of the carriage in Table II. This gun is designed for a muzzle velocity of 2700 ft. per second, which gives an energy of 632 foot-tons, and being alternatively quick-firing or semi-automatic in its action, it is possible to fire twenty-five aimed rounds per minute. The breech mechanism is of the vertical sliding-block type, the block being operated by a crank pivoted in the breech end of the gun. In semi-automatic firing the crank is rotated by a pawl, which engages with

a cam on the crank-axis, when the gun is returning after recoil. This action opens the breech, at the same time winding up a powerful clock spring attached to the crank-axis. During the opening of the breech the cartridge-case is ejected by means of a powerful extractor, which is actuated by the breech-block during its fall. A slow initial movement of this extractor exerts a powerful wedging action on the case, dislodging it prior to its rapid ejection. In loading, the cartridge is pushed smartly into the chamber. This action releases the breech-block, retaining devices, whereupon by the reaction of the clock spring the breech is closed. In "quick firing" the action of the mechanism is the same as in "semi-automatic" firing, excepting that the breech is opened and closed by means of a hand-lever mounted in a bracket on the side of the gun-cradle. When using the mechanism for quick firing, the spring gear is removed intact, and the semi-automatic action pawl is rendered inoperative by means of a switch on the gun-mounting.

THE 75-MM. FIELD-GUN

In view of the re-arming of our field forces, the illustrations * * * * of the 75-mm. field-gun and of the 4.33-in. howitzer are of interest. The 75-mm. gun (Fig. 1) has been designed to fire a 14.33-lb. shot at a muzzle velocity of 166 ft. per second, or a 12.5-lb. shot at 1800 ft. per second, at the rate of twenty-five rounds per minute. With an elevation of 16 deg. the range is about 4 miles. The weight of the mounting for the heavier gun, with limber and twenty-four rounds, is 1 ton 5¼ cwt. The gun itself is of nickel-steel construction, and the heavy jacket shrunk over the A tube extends the whole length of the gun, and both are locked together by the breech-ring, which carries the breech-closing mechanism, and has a lug connecting the gun to the recoil system, as shown in the view. The breech mechanism is of swing-block type, the block being screwed into a carrier, which is pivoted, between lugs on the breech end of the gun. The mechanism is operated by a hand-lever mounted on the carrier, and provided with a bevel-pinion, which engages with bevel-teeth at the rear of the breech-screw, so that a horizontal movement of the hand-lever rotates the breech-screw, thus unlocking it. The continued movement of the hand-lever swings the mechanism clear of the breech opening. The hollowed interior of the breech-screw receives the firing-gear, which is of percussion "slip-lock" type, by means of which, if necessary, repeated blows may be given the primer without opening the breech. A powerful case-extractor is actuated by the carrier when the mechanism is swung out, and a cartridge-retainer is provided, which prevents the cartridge slipping out of the chamber when the gun is loaded at high elevation.

The carriage, which is so well shown in Fig. 1, is designed to remain steady when firing at a few degrees of depression. It has the independent line of sight, and is fitted with telescopic, open, and goniometric sights. A bullet-proof steel shield, 0.144 in. thick, is provided for the protection of the men engaged in working the gun. The gun and cradle are carried on an upper carriage, which may be traversed 4 deg. to right or left, and the gun may be elevated up to 16 deg. or depressed to 10 deg. on the carriage. The full elevation may be given with either the ranging or the pointing gear. The gun is placed at full elevation for travelling, and is locked to the trail by means of a sliding bolt on the trail, which engages with a lug on the cradle in such a way as to relieve the travelling stresses on both the elevating and the traversing gears. The pointing-screw is entirely protected from dust when travelling. The wheels are 55 in. in diameter, and the track is 55 in. The cradle is of box section, having slides for the gun machined on the cover, and lined with gun-metal. The front cover may be easily removed for inspecting the buffer glands or withdrawing the spring column. The running-out springs are arranged in a single column round the buffer cylinder, which recoils with the gun, the whole being enclosed in the cradle, and thus protected from dust or injury. The buffer and springs may be withdrawn from the cradle without disturbing the adjustment of the springs. The buffer piston-rod is of steel, and is attached to the front cover of the cradle. The recoil-control gear ensures the pressure in the cylinder to be such that uniform stability during recoil is secured, and the counter-recoil of the gun occasions no shock to the carriage.

The upper carriage is built up of nickel-steel side-plates connected with transoms, one of which carries the socket for the traversing pivot. The rear transom is clipped to a bracket on the trail. The traversing gear is connected to a socket on this bracket and to the rear transom of the carriage. The rear transom also carries the lower bearings for the ranging and pointing gear. The nut through which the pointing-screw works is carried in the lower bearing on the left-hand side of the carriage, and is rotated by means of bevel-wheels and a hand-wheel.

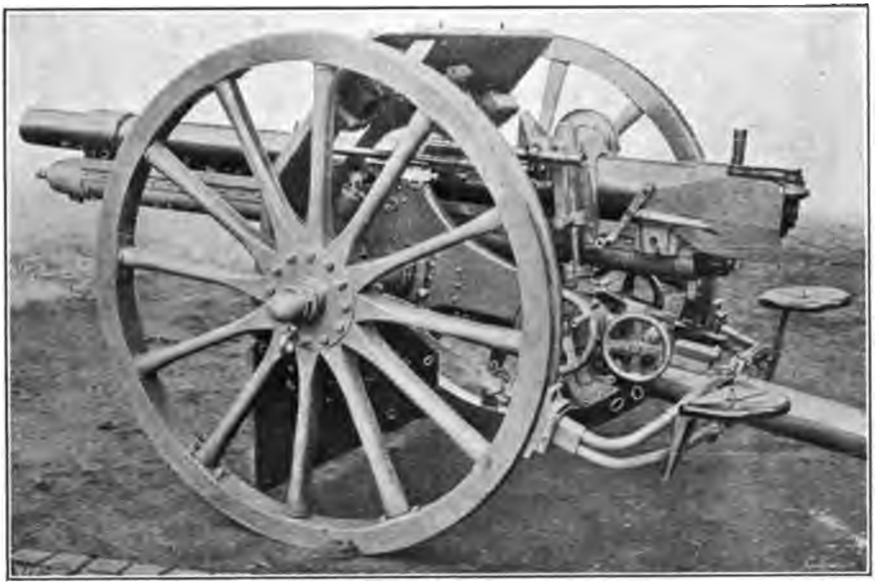
The ranging-screw is of steel, and has an extension-piece fitted in the pointing-screw. The ranging-screw is rotated from the right-hand side of the carriage by means of a hand-wheel. The ranging-screw works through an oscillating nut carried by a saddle on the cradle, in such a way that it cannot rotate with the ranging-screw.

The sight is connected to the coupling on the pointing-screw, so that, when using the pointing-gear the gun and sight move together, and when using the ranging-gear the gun moves without moving the sight. The range-dial is actuated by a pinion engaging with a rack on the sight-bracket. The goniometric sight is carried by a stem, on which it may be raised above the shield for indirect firing.

The trail is tubular in section, and is fitted with a spade, trail-eye, lifting-handles, and handspike. It also carries brackets for the brake gear and shield. The axle-tree is of steel, and passes through bearings in the sides of the upper carriage. The brakes are provided with a quick-releasing gear, worked by a handle on the left-hand side. The seats are carried on the brake support arms. The lower part of the shield is hinged, so that it may be folded up and locked to the trail for travelling; the shield being kept as near as possible to the trunnions, the clearance-holes for the gun and sights are small.

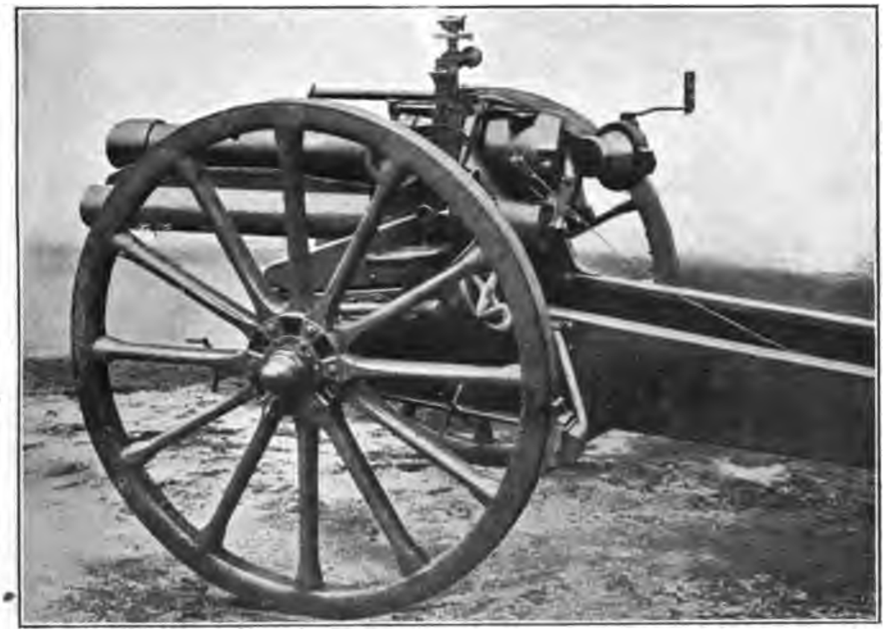
THE 4.33-IN. HOWITZER

The 4.33-in. Howitzer, illustrated in Fig. 2, fires a projectile af 35½ lb. with a velocity of 1100 ft. per second, giving a maximum range of about 4½ miles. The barrel and breech mechanism are generally of similar construction to those of the 75-mm. field gun described, but there are, of course, important differences in the mounting or carriage. The trail is of double-channel section, built up of nickel-steel flanged plates, strengthened with transoms, one of which, near the forward end, is adapted to receive the training-pivot. It is filled with bronze bearing-brackets to support the upper carriage, which is secured at the front end by clips, and at the rear by bolts fitting in radial slots in the bearing-brackets. The rear end of the trail is



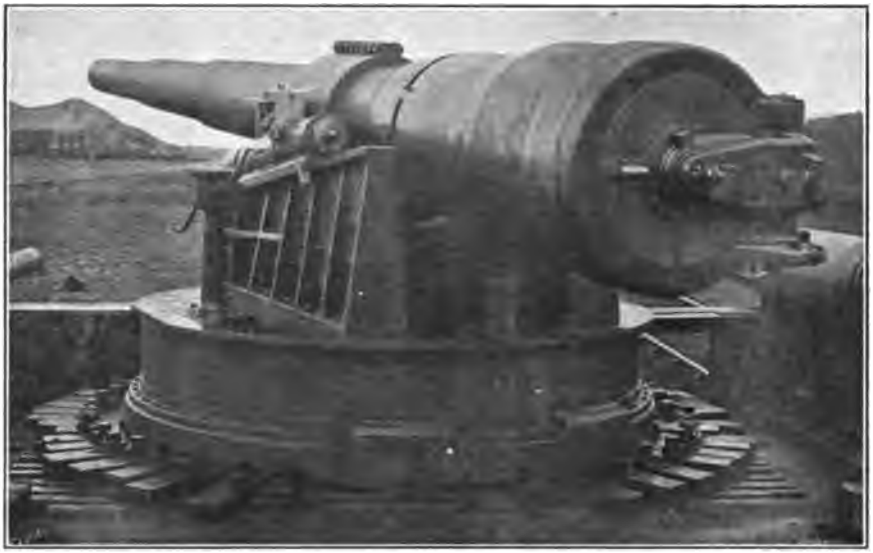
Engineering.

FIG. 1. 75-MILLIMETER FIELD-GUN



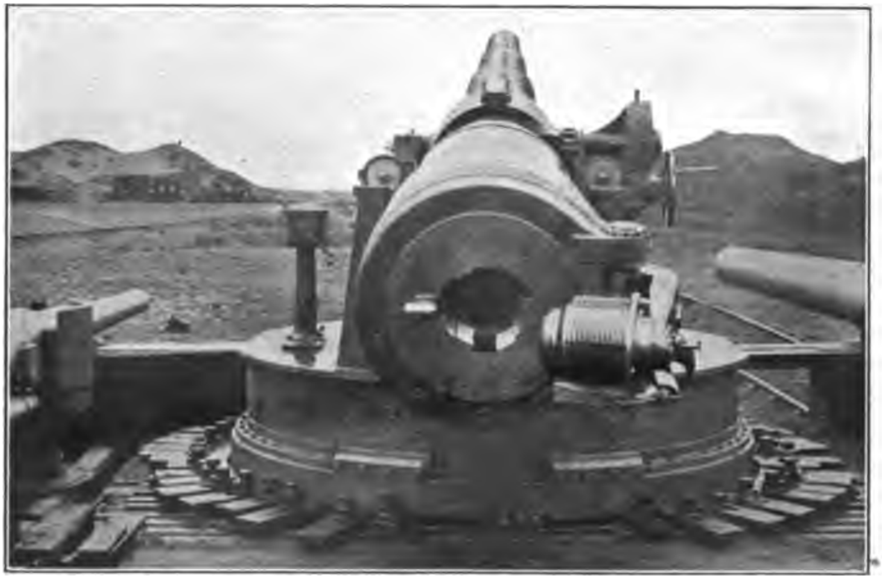
Engineering.

FIG. 2. 4.33-INCH HOWITZER



Engineering.

FIG. 3. 12-INCH 50-CALIBER NAVAL GUN ON TRIAL MOUNTING



Engineering.

FIG. 4. 12-INCH 50-CALIBER NAVAL GUN, SHOWING BREECH OPEN fitted with trail-eye and lifting-handles. The traversing handspike is hinged at the rear end of the trail, and, on moving a spring-catch with the foot, it is released from the traversing position, and may be folded back on the trail for travelling. The rear end of the trail is fitted with a powerful double-bladed spade, with large bearing-plates and stiffening gussets.

The upper carriage is built up of two forged-steel side cheeks connected together by a steel transom, on which are formed the bearings for the oscillating box for the elevating-gear, the sockets for the trunnions of the balancing-spring, and, at the rear, a socket for the traversing pivot. In order to obtain a long recoil at full elevation the gun and buffer cylinder are kept well forward, their center of gravity being in front of the trunnions. The elevating-gear is relieved of the load due to this by means of a balancing-spring. This spring is enclosed in a case for protection. The gun may be loaded at any angle of elevation.

The elevating-gear allows of 50 deg. elevation and 5 deg. depression being given to the gun. It consists mainly of a steel screw attached by a pin-joint to lugs on the underside of the buffer cylinder and working through a steel nut carried in an oscillating box, which is trunnioned in bearings on the transom of the upper carriage. The nut is rotated by means of bevel-wheels and shafts from a hand-wheel at the right-hand side of the carriage. The traversing-gear allows of 3 deg. traverse right and left. It consists of a steel screw attached by a pin-joint to a bracket on the trail, and working through a nut carried on the upper carriage by an extension of the elevating-gear bracket. This nut can be rotated by means of a hand-wheel and bevel-wheels. The hydraulic buffer-cylinder is provided with keys to take the guides on the slide.

The slide which carries the gun is of steel, machined to fit the keys on the buffer cylinder. The gun is attached to it at the forward end by means of a bolt passing through the slide and through a lug on the gun body. At the rear end the gun is held in place by a tongue on the slide which fits in a recess formed in a lug on the gun. The piston-rod is secured to a lug on the breech end of the gun. The running-out springs are supported by the running-out rod passing through them. To remove the springs it is only necessary to remove the nut at the breech end of the gun, and the nut attaching the rods to the gun at the muzzle end.

The wheels are 56 in. in diameter with steel tires 3 in. wide on the face. The track is 62 in. The wheel brakes are provided with a quick-releasing gear worked by a handle on the left-hand side.

A goniometric sight is provided on a bracket attached to the trunnion on the left-hand side of the carriage. By this arrangement the sight traverses with the gun, and the eye-piece is always in approximately the same position when the sight is in use. The gun may be layed correctly without calculation, whatever may be the inclination of the trunnions from the horizontal plane; the sight may be used for any angle of elevation of the Howitzer. The optical head of the sight is carried up above the wheels, and a view may be obtained in any direction without moving the eye-piece of the sight.

There are many other interesting exhibits connected with land artillery; but we may pass on to naval ordnance, referring the reader to the Tables I and II for the ballistics of other field-guns.

THE 12-INCH 50-CALIBER NAVAL GUN

Table I further simplifies our task so far as naval weapons are concerned, since it gives the ballistics and weights of mountings of the latter quick-firing and machine guns. The improvements introduced are mostly in detail, all tending to increase power and accuracy, and thus visitors view with interest such features as follow-the-pointer sights, &c. These, however, have already been dealt with in *Engineering*, and pressure on our space compels us to confine attention to the 12-in. 50-caliber gun, exhibited in models. It is true that these are not the weapons actually made for the British Navy, but they represent the Vickers' practice, and the drawings and illustrations which we reproduce on * * * (Figs. 3 and 4) are therefore typical of the armament of the latest battleships of more than one power. Figs. 3 and 4, * * * show a gun on the trial mounting at the company's Eskmeals range on the Cumberland Coast. Figs. 5 and 6 are sections respectively of a solid-steel and wire-wound gun of 50 calibers in length, to give the same ballistics, while Figs. 7 to 14 illustrate completely the breech mechanism with the modifications recently introduced.

The comparative sections will be studied with interest in view of the controversy which is reawakened from time to time as to the advantages and disadvantages of the wire-wound and the solid-steel systems of construction. Now that steel of a thoroughly reliable character is obtainable for guns, there is not the same objection to the use of steel rings shrunk on to reinforce the inner tube instead of wire, especially as the latter is more expensive to manufacture; but while the Vickers Company make both types, the British Navy still prefers the wire-wound gun, probably because it ensures much greater radial strength, and also because any fracture of the inner tube due to excessive stress is not likely to cause disaster, and may be easily repaired.

The all-steel gun (Fig. 5) is built up of parallel tubes shrunk one over the other. The A tube is a stout tube of nearly uniform section from end to end. Over this is shrunk the B tube in four portions, extending the whole length of the gun, the interior of the B tube being a trifle less in diameter than the exterior of the A tube before the tubes are built together. The C tube is next shrunk on in three pieces, which extend nearly to the muzzle. There is again a slight difference in the exterior of the B tube and the interior of the C tube preparatory to shrinking; in this case the difference is somewhat greater than between the A and B tubes. Next comes the D tube, in one piece about half the length of the gun, and it is followed by a short jacket. These two last tubes are shrunk on in the same manner as the B and C tubes. the amount of shrinkage increasing with each successive tube. It will be understood that the amount of this shrinkage is an important factor in a gun constructed on this principle; the manufacture of the gun demands a fine degree of accuracy also in the processes of machining. The breech-bush which carries the breech-screw or plug is screwed into the D^1 tube, and a ring is shrunk over the rear portion of the breech-bush. Over this ring and a part of D^1 the tube is shrunk a collar, which, in combination with the D^1 tube and the breech-ring, withstands the rearward pressure when the gun is fired.

In the case of the wire-wound gun (Fig. 6) there is an inner A tube, whose exterior diameter is decreased towards the muzzle, due to a slight taper and the existence of a number of small shoulders. The interior of the next tube—the A tube—has its inside diameter somewhat less than the exterior diameter of the inner A tube. The outer tube is slightly heated, and the inner A tube is forced into it until the shoulders on the inner tube are brought up against the shoulders on the outer tube. Layers of steel wire are wound on the outer

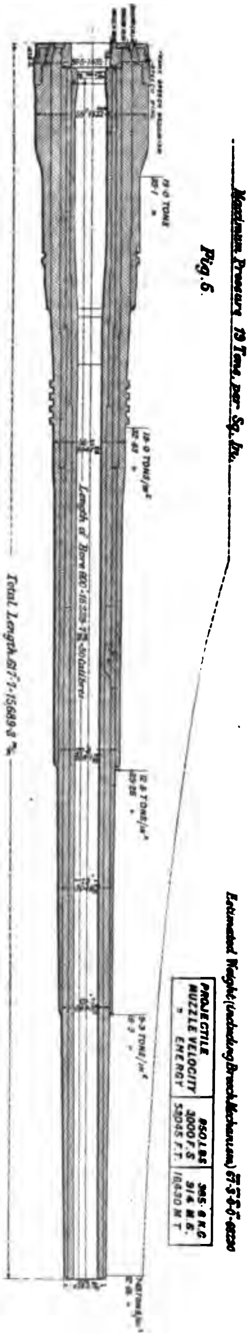

Maximum Pressure 19 Tons per Sq. In.
19·0 TONS
19·0 TONS/in²
12·8 TONS/in²
9·3 TONS/in²
Length of Bore 600"·15 239·7 % ·50 Calibres
Total Length 617"·7-15689·8 %
Estimated Weight (including Breech Mechanism) 67-3-5-0-68220

Fig. 6.

PROJECTILE	850 LBS	385·6 K.G.
MUZZLE VELOCITY	3000 F.S.	914 M.S.
" ENERGY	53045 F.T.	16430 M.T.

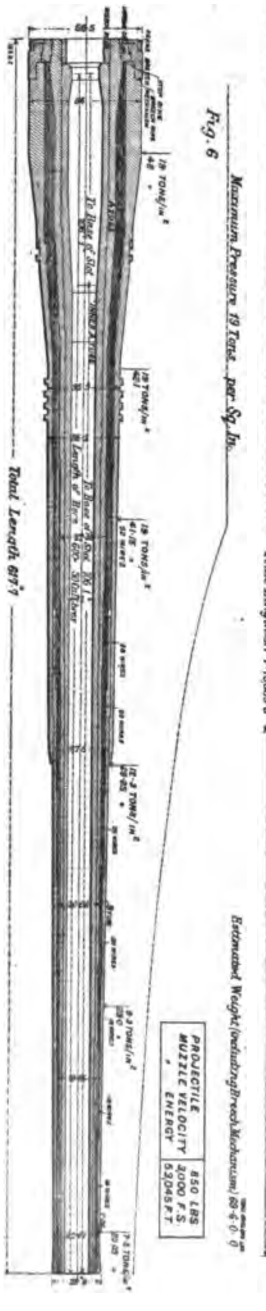


Fig. 6

PROJECTILE	850 LBS
MUZZLE VELOCITY	3000 F.S.
" ENERGY	53,045 F.T.

Fig. 7.

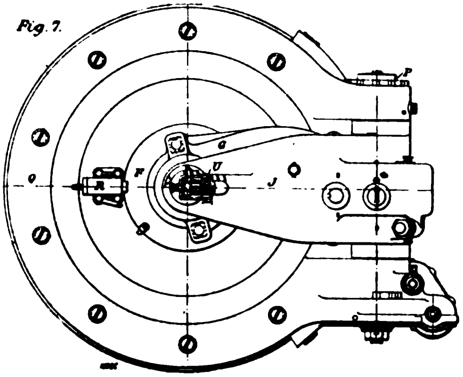


Fig. 8.

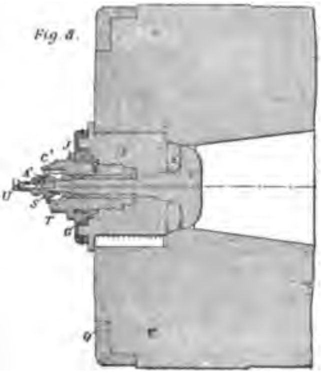


Fig. 9.

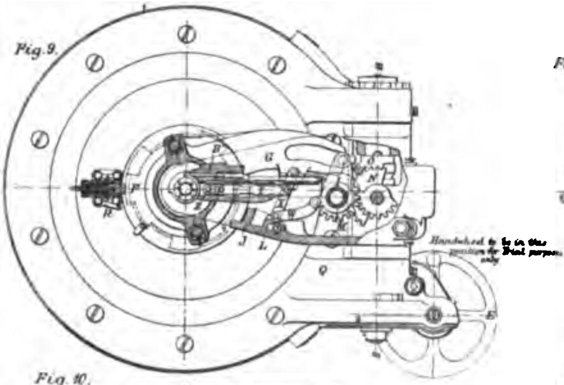


Fig. 11. SECTION B.B

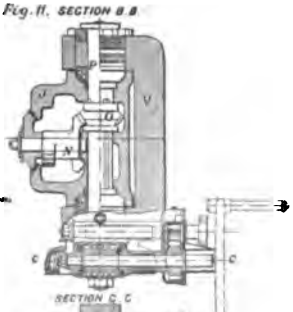


Fig. 10.

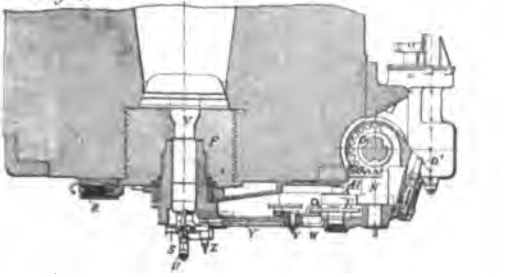
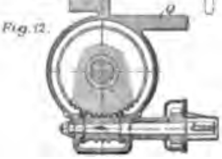


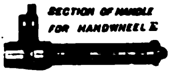
Fig. 12.



SECTION D D.

Fig. 13.

Fig. 14.


SECTION OF HANDLE FOR HANDWHEEL E

tube at varying degrees of tension, the number of layers increasing from sixteen at the muzzle to eighty at the breech end. About 130 miles of wire, having a cross-section of 0.25 by 0.06, and a tensile strength of 100 tons per square inch, are used in the manufacture of this gun. The jacket and the B tube are then put on over the wire. The breech of the gun is closed by a breech-screw or plug, which works in the breech-bush, the breech-bush in its turn being screwed permanently into the A tube. Over that part of the A tube which is not reinforced by the wire is shrunk a collar, which, in combination with the breech-ring, assists the A tube to take up the longitudinal stresses which occur on firing the gun.

The breech mechanism, illustrated by Figs. 7 to 14, * * * is operated by a hand-wheel E, situated on a non-recoiling part of the gun-mounting, and also by power gear, both of which work through worm-gearing, shown in Figs. 11 and 12. The breech-screw threads are arranged in segments of varying radii, and the screw F is rotated by a couple-lever G. Engaging with a groove in the breech-screw lever G is a roller H, which projects from the arm of a crank-pinion I, mounted on the carrier J. The form of the groove, and its position in relation to the crank-pinion I, is such that the maximum possible power is exerted when seating the obturator K, and a "locking-point" is obtained when the breech is closed. When the breech-screw F is in the unlocked position, and swung away from the breech face, it is retained against rotation by a spring-catch L, of the well-known plunger type, which engages with the breech-screw lever G. The crank-pinion I is provided with a roller-bearing M to eliminate, as far as possible, the friction of the toggle-joint action of the crank, before the final operation of seating the obturator K. The crank-pinion I is operated by an intermediate pinion N, which is in turn operated by a bevel-pinion O on the hinge-bolt P of the carrier J. The hinge-bolt P is operated by the worm-gear mounted at its lower extremity in a bracket on the frame Q. The carrier hinge is provided with ball anti-friction bearings. Two series of balls are provided—one series to take the side thrust, and the other to take the dead-weight of the mechanism. The bearings are arranged so that it is possible to remove either of them intact without dismantling the carrier J and breech-screw F. These bearings can be vertically adjusted for centering the carrier J and breech-screw F when the mechanism is assembled, the bushes being rotated by means of adjusting washers. An automatic rebound catch R is provided for retaining the breech-screw F after slamming, and thus preventing rebound. The axial vent-nut T and the box-slide S are arranged to prevent the slacking back of the nut T, the latter being also constructed so as to limit the forward movement of the axial vent V and the consequent displacement of the obturator K.

Obturation is effected by means of a plastic canvas-covered pad, with a copper protecting disc and steel rings. The mechanism is provided with separate electric and percussion firing-locks. The electric lock J is clearly shown in Fig. 14.

The firing-gear is operated by means of a link system, in place of the usual cam-plate method, and with the addition of an appliance for withdrawing the firing-needle into a safe position before the lock-frame commences to move in the box-slide S.

This link system consists of a link W, pivoted at one end to the crank-pinion I, and at the other to an intermediate lever X swinging in the carrier J, which, in turn, engages with a link Y coupled direct to the guide-bolt Z of the lock-frame. The leverages of this intermediate lever X are adjusted, with relation to the crank-pinion link W and the link-actuating lock Y, so as to reduce the somewhat considerable movement of the crank-pinion I to the smaller movement required on the lock U, at the same time maintaining the slow initial movement of the latter during the wedging out of the vent-sealing tube A^1.

The method of retracting the needle is as follows:—A sliding-bar B^1 works in guides in the carrier J. This bar B^1 engages at one end with a withdrawing lever C^1 pivoted on the box-slide S, the other end being provided with an anti-friction roller, which engages with a flange on the crank-pinion I. Immediately the crank-pinion I is rotated (and during the idle movement of the latter relative to the breech-screw lever G), an incline on the flange engages with the roller of the bar B^1, forcing the bar B^1 towards the lock U, and thus withdrawing the firing-needle through the agency of the withdrawing lever C^1. During the opening of the mechanism, the flange on the pinion I, which is concentric after the initial incline, continues to engage the roller on the bar B^1, and retains it in the retracted position until the breech is again closed and the screw F locked. The bar B^1 and the lever C^1 are provided with spring-plungers, which return these parts to their normal position when the mechanism is closed for firing. An hydraulic buffer D^1 is provided in the carrier J to absorb the shock when opening.

The breech can be opened or closed, when hydraulic power is applied, in a little under 4 seconds, and with hand-power only in 6 seconds. This result, in combination with the arrangements made for the supply of ammunition to the gun, has had great influence on the rapidity of fire of even the largest of guns. It will be seen that in Table I the rate is two rounds per minute for this 12-in. gun, which develops 53,400 foot-tons of energy at the muzzle, equal to penetrating 52.1 in. of wrought iron, according to the Gavre formula. When one recalls also the immense bursting-charge which the 850-lb. shell can carry, it is easy to realise how naval strategists and tacticians have shown a preference for the 12-in. gun instead of a combination of 12-in. and 9.2-in., or 12-in. and 10-in. guns. As to whether it is the 6-in., 5-in., or 4-in. gun which should be associated with the 12-in. gun, is another question, regarding which it need only be said here that there are exhibited 6-in. and 4-in. quick-firers equally efficient for their caliber with the 12-in. gun described, while further interest is lent by the collection of ship models and electrical manufactures of the company.—*Engineering*, Aug. 12, 1910.

◆ ◆ ◆

FOUR RECENT TYPES OF DREADNOUGHTS*

A DISCUSSION OF THEIR COMPARATIVE MERITS

By LUIGI BARBERIS, Captain Corps of Construction, Royal Italian Navy

Since the promotion of Sir Philip Watts to the post of Chief Constructor of the British Navy, there have been introduced into the service of that great marine many innovations, good and otherwise. Among them one which has excited an infinite number of protests and criticisms; that is, the principle of secrecy regarding the plans for new construction.

Other navies follow more of less the example of England; and for several years the reviews, annuals, and naval almanacs have been giving incomplete and inexact vignettes of dreadnoughts of various nations.

---

* Translated for the *Scientific American Supplement* from *Rivista Marittima*

In the last few months, however, by a set of curious circumstances, there have come to light the schematic designs of four types of the most recent dreadnoughts, none of which ships has yet been launched. These plans have every appearance of authenticity, and are derived from such reliable sources that, although they are neither official nor semi-official, they may be considered sufficiently trustworthy to merit attention.

These four types of dreadnoughts are:

a. The *Sebastopol* class, Russians, to which belong the *Petropavlovsk*, the *Gangut*, and the *Poltava;* laid down with great pomp simultaneously on June 15th, 1909, at the Baltic works and the Obukoff yard.

b. The *Wyoming* and the *Arkansas*, Americans; the contract for the former was awarded to Cramps on October 14th, 1909; that for the latter to the New York Shipbuilding Company on September 25th of the same year.

c. The *Rivadavia* and *Moreno*, Argentines, awarded to the Fore River Iron Works on January 21st, 1910. (Contract for one of these was sublet to the New York Shipbuilding Company.)

d. The *Jean Bart* and the *Courbet*, French, whose plans were finally approved by the Ministry April 16th, 1910, and turned over to the Brest and Lorient dock yards on the 7th of May.

The publication of the plans of the French and the American ships is scarcely cause for surprise, for in addition to the liberality usual to these two navies, there are certain legislative reasons why the data relative to new construction must be made public in parliamentary documents.

The *Moniteur de la Flotte* of June 11th, which published the details and vignettes of the *Jean Bart*, enjoys such a reputation for reliability and close connection with current affairs that we cannot doubt the exactitude of its information.

The best information concerning the *Wyoming* appeared in a notable article in the June, 1910, number of *The Navy*.

The sketches and data concerning the four Russian battleships are taken from an exhaustive article in *Engineering* of May 20th, 1910. This journal is too well known to allow of our questioning the source from which it derived its facts; and their authenticity is further substantiated by the lively comments provoked in Russia by their publication.

As to the Argentine vessels, a sufficiently ample description appeared in the official *Boletin del Centro Naval* in its January, 1910, number; but other details have also come to hand in Argentine (*La Nacion*) and foreign (*Scientific American*) papers, which we have every reason to believe are thoroughly dependable.

It is interesting to examine somewhat carefully the origin of the drawings and descriptions which have repeatedly appeared in numerous technical publications (including the *Rivista Marittima*), because in order to comment on the plans of the several projected vessels and compare their points of difference, it is essential that the authorities cited shall be as near absolute as possible.

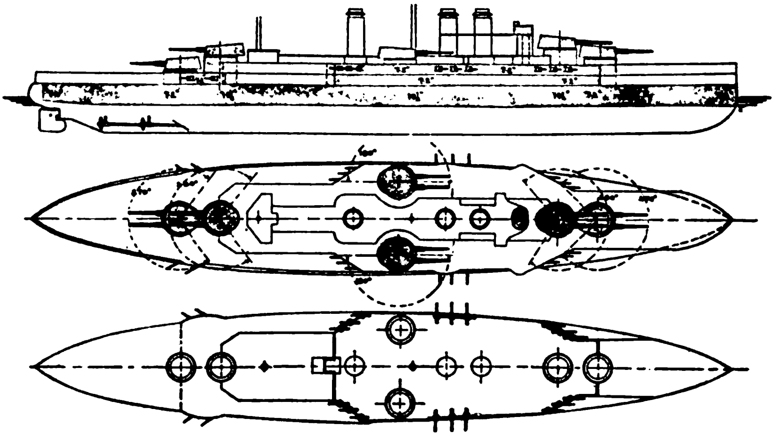
The four designs are not quite contemporaneous, and it should be noted that the Russian dates from the spring of 1909, the American from that summer, and the French and Argentine from the end of that year.

MAIN ARMAMENT

The comparison of the main batteries of the four dreadnoughts which we are considering is made particularly easy and interesting by the fact that all the ships carry twelve 12-inch (305-millimeter) guns.

The first thing that strikes the reader after a glance at the accompanying diagrams is that the French have sacrificed one-sixth of the gun power of their ships in the sector of maximum offense (the broadside) merely to reinforce the bow and stern fire. It stands to reason that during the greater part of a fight one of the flank turrets of the *Jean Bart* would remain perfectly useless. Even in those few moments in which the ship would have occasion to fire in chase or in retreat, the ballistic efficiency of the vessels would not be eight guns (as it might at first sight appear, and as the *Moniteur de la Flotte* erroneously maintains), but six, as shown clearly in the diagram. The solution adopted in the Argentine navy proves that it is possible by other means to get the fire of six guns along the line of the keel while still conserving all twelve for use on the broadside.*

The Americans seem content with a fore and aft fire (within 15 degrees each side of the keel line) of but four guns, and the Russians have only three which can fire end on within 25 degrees of the longitudinal axis. The latter, however, have made up for the loss of end-on efficiency by a splendid broadside fire of all twelve guns throughout an arc of 130 degrees (according to *Engineering*). Amazing as it may seem, the Yankees have not taken advantage of the splendid system which they first introduced, and have contented themselves with a maximum arc of but 95 degrees, only slightly different from that of the French (90 degrees) and Argentine (100 degrees) ships. This seems all the more remarkable because America gave us the classic commentary of Commander Niblack, in which the importance of an ample arc of maximum offense was ardently upheld, not only by Commander Niblack, but also by Rear Admiral Wainwright and Commander Sims.



FRENCH "JEAN BART"

Displacement, 23,323 tons. Speed, 20 knots. Maximum coal supply, 2,700 tons. Armor: Belt, $10\frac{3}{4}$ inches to $7\frac{1}{2}$ inches; turrets, $10\frac{1}{2}$ inches. Armament: Twelve 12-inch; twenty-two 5.5-inch. Torpedo tubes, four 18-inch.

However, if the Americans have been able to give to turrets Nos. 4 and 5 a range of 75 degrees fore and aft of the beam—a maximum never before achieved—we may assume that they must have had good reasons for limiting to 45 and 50 degrees the range of Nos. 2 and 3, respectively.

---

* An idea of the sacrifice made by the Frenchmen may be got by taking the sum of the arcs of fire of the individual guns and dividing by twelve. Thus: *Rivadavia*, 293 deg.; *Wyoming*, 288 deg.; *Sebastopol*, 285 deg.; *Jean Bart*, 243 deg.

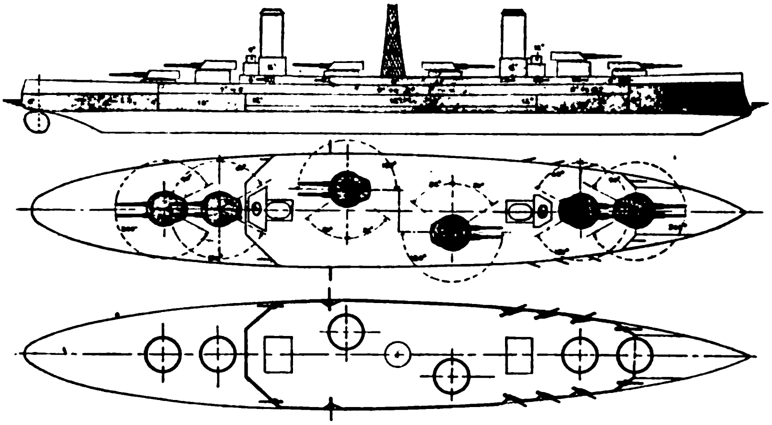
TORPEDO-DEFENSE ARMAMENT

It is a pity that the sketch in *The Navy* did not indicate the disposition of the twenty-one 5-inch guns of the American ships, although it is reasonably certain that sixteen of these are in casemates on the gun deck, and one in the stern.

The sixteen 4.7-inch (120-millimeter) of the Russian battleships are placed in battery on the gun deck.

Of the twenty-two 5.5-inch (140-millimeter) guns on the *Jean Bart*, eighteen are in an armored redoubt on the main deck in a prolongation of the forecastle, and only four are on the gun deck.

The twelve 6's of the *Rivadavia* are contained in a redoubt similar to that on the *Jean Bart*, but the location of the twelve 4's is not definitely known.



ARGENTINE "RIVADAVIA

Displacement, 27,533 tons. Speed, 23 knots. Maximum coal supply, 4,000 tons; 660 tons oil. Armor: Belt, 12 inches to 4 inches; turrets, 9 inches. Armament: Twelve 12-inch; twelve 6-inch; twelve 4-inch. Torpedo tubes, two 21-inch.

The French and the Argentines have given the problem of torpedo defense a highly modern solution. Therefore it seems strange that the American design has retained the 5-inch on the gun deck especially after this location had been condemned at the Newport conference of July-August, 1908,* where the report of Engineer Robinson (with comments by Rear Admiral Evans) made after the round-the-world cruise of the fleet, caused great discussion and no end of argument. And the most surprising thing of all is that Robinson was Capps's most active collaborator in preparing the plans of the *Wyoming*.

The distribution of the arcs of fire on the Frenchmen is far from ideal, and in all probability this may be said of the other three types as well. The French have only three pieces in the part of the ship most vulnerable to attack, namely, forward; on the other hand, they have an unnecessarily large number (eleven) in broadside. In the *Rivadavia* only one, or at most two, of the 6's can fire along the line of the keel. From this point of view the *Sebastopols* are better off, where by means of an old and little-praised artifice—well-rounded sponsons—four guns on each side have a bow or stern fire.

---

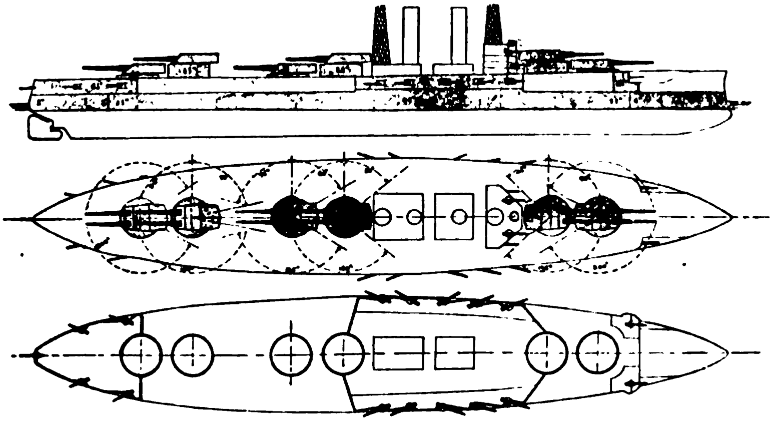
* Resolution No. 3, carried by 50 votes to 11, stated: "That the 5-inch battery of the *North Dakota* is too low to be used efficiently in ordinary trade-wind weather."

The French idea of arming the after part of their men-of-war more completely than the bow is rather surprising in view of the findings of our Commander Vannutelli, R. I. N., after considerable analytic study. These are that under an attack by torpedo craft, the shorter period of time in which firing is feasible at the forward end of the ship necessitates the concentration there of the majority of the secondary guns.

As to the choice of calibers, there is not much room for argument. Certainly one would not have expected that the Argentines, having frankly adopted the principle of a uniform caliber for their main battery, would not follow the lead of other navies and adopt it for the anti-torpedo battery.

SUBMARINE ARMAMENT

The *Jean Barts* have four under-water torpedo tubes, but these are still only 18-inch, like in the earlier French ships. The *Wyomings* and *Rivadavias* are fitted but with two tubes each, but of 21-inch diameter. In the *Sebastopols* the torpedo tubes have been altogether omitted, so we thus see all the modern tendencies represented.



UNITED STATES "WYOMING"

Displacement, 25,298 tons. Speed, 20.5 knots. Maximum coal supply, 2,500 tons; 400 tons oil. Armor: Belt, 11 inches to 5 inches; turrets, 11 inches. Armament: Twelve 12-inch; twenty-one 5-inch. Torpedo tubes, two 21-inch.

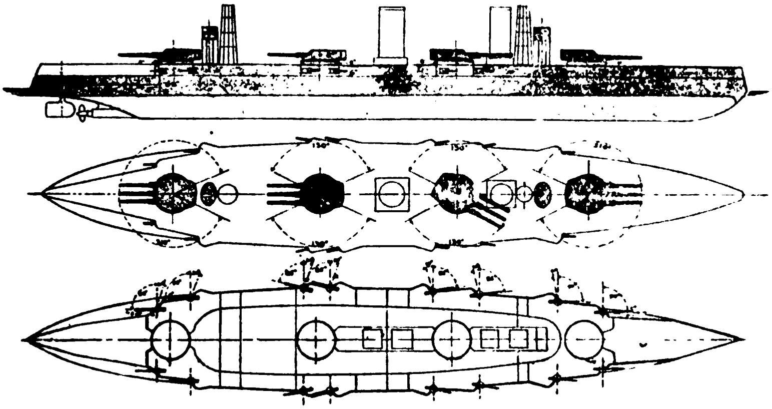
FREEBOARD AND HEIGHT OF GUNS

The *Rivadavias* and *Jean Barts* are designed with a topgallant forecastle which extends aft for about two-thirds of their length, the after part forming the armored redoubt for the secondary battery guns. In the *Jean Bart* the freeboard at the bow is 23½ feet; amidships, 22½ feet, and little more than 16 feet at the stern. The *Rivadavias* bow is 26 feet above the waterline; her freeboard is 23 feet amidships and 17 feet aft. Notice that the Argentine ships have been given a considerable sheer.

Concerning the *Wyoming*, the data are somewhat mixed, the sketches in *The Navy* and *The Army and Navy Register* not showing any topgallant forecastle, as have the *North Dakotas* and *Utahs;* on the other hand, the text gives the height of the forecastle at 24½ feet, while the freeboard amidships is 21⅓, and aft 18¼ feet. We may safely say that there is no topgallant forecastle; but we cannot understand how the poop can be so low unless it has one deck less, for we notice that the height of the quarter-deck guns is given as 25¼ feet, which should denote (if the plan of the *Utah* is followed) a freeboard aft of about 21½ feet.

The *Sebastopols*, according to *Engineering*, appear to have one continuous deck from stem to stern, with about eighteen feet of freeboard.

Upon examining these figures, we are struck with the fact that all these ships are exceedingly long and low in the water. They are all—especially the Frenchmen—lowest at the after end. In Italy, where we have just begun, in the *San Giorgio*, to pay attention to high freeboard (which has been retained in the *Dante Alighieri* and *Giulio Cesare*) this point might perhaps with profit be discussed. A diminution of two or three feet in the height of the ship's sides not only effects a very considerable economy in the weight of the hull and armor, but also reduces the probability of being hit at long range. It might even give, according to computations already made, an added defensive power equal to a noticeable increase in the thickness of the side armor.



RUSSIAN "SEBASTOPOL"

Displacement, 23,000 tons. Speed, 22.5 knots. Maximum coal supply, 3,000 tons. Armor: Belt, 8¾ inches to 6 inches; turrets, 8 inches. Armament: Twelve 12-inch; sixteen 4.7-inch Torpedo tubes, none.

The heights of the axes of the various guns on the four ships above the water are as follows:

	Rivadavia. Feet.	Wyoming. Feet.	Jean Bart. Feet.	Sebastopol. Feet.
Turret No. 1	32	30	31	29 (about)
Turret No. 2	40	37	38	29 (about)
Turret No. 3	32	34	25	29 (about)
Turret No. 4	32	27	25	—
Turret No. 5	32	32⅓	28½	29 (about)
Turret No. 6	22½	25	21⅓	29 (about)

Above a certain amount, from 25 to 26½ feet, the advantages of height above the water level are no longer felt, hence the frugality displayed by the French in this regard appears wise. If the height of the battery had any great military significance, the wisdom of the Russian plan would become apparent—that is to say, all guns the same height without sacrificing any of them.

Concerning the torpedo-defense guns, the only data we have concerns the *Rivadavia's* 6's, which are 19⅓ feet above the water, and those of the *Jean Bart*, 19 feet, except the four stern guns, which being only 12 feet above the water will hardly ever be able to be fired.

VERTICAL PROTECTION

The Argentine vessels have the thickest armor belts. For some 250 feet amidships the *Rivadavia's* main belt has a thickness of 12 inches, and rises some 4½ feet above the normal water-line. Eighty feet forward and 70 feet aft of this main belt the plates are 10 inches thick, and thence to the bow and stern measure 6 and 4 inches, respectively.

In the Americans the width of the main belt above and below the water-line is about the same; the part protecting the ship's vitals is 400 feet long and 11 inches thick, which is gradually reduced to 5 inches at the extremities.

The belt of the *Jean Barts* extends upward from the load-line for 7¾ feet with a thickness amidships of 10¾ inches, tapering to 7½ at the ends, but we do not know just how long the main belt is.

In the Russians the armor is 8¾ inches thick for 370 feet amidships, the top of the belt being about 10 feet above the water-line. Fore and aft it is of 6-inch steel. There is, moreover, one peculiarity; at a distance of about 11 feet from this belt, on either side of the ship, is a vertical wall of 3 to 4-inch armor. "Would not this weight be better utilized," says *Engineering*, "if added to the main outside belt?"

The upper deck sides of the Argentine ships are protected by plates ranging from 9 inches at the bottom to 8 at the upper edge. These extend fore and aft for 400 feet. Forward to the bow is 6-inch armor, and only at the very stern is the ship's side unprotected. The main deck redoubt has 6-inch covering, except the extreme forward part of the topgallant forecastle.

The French as usual are more conservative in extending the armored surface. This reaches the main deck only for a distance of 206 feet amidships, and for another 36 feet in the wake of the two quarterdeck turrets—in all, 242 feet. Besides the main-deck redoubt is armored for 206 feet, but all this upper side armor is of the modest thickness of 7 inches (178 millimeters); hence the gun deck is less well protected than in the Argentines, but the main-deck redoubt more so.

The *Wyoming's* heavy belt only extends to the gun deck—9 inches above the main belt for 400 feet. The space between the gun deck and the main deck has 6.6-inch plates only.

The upper strakes of the Russian ships are 6 inches thick in the middle and 3 inches at the bow.

From these data we are enabled to compile the following table, which gives an approximate idea of the percentage of sides of the repective ships covered with armor, together with the percentages of the various thicknesses:

Rivadavia.

1,130 square feet of	12-inch, or	8.5
700 square feet of	10-inch, or	5.5
5,000 square feet of	8.5-inch, or	39.0
3,981 square feet of	6-inch, or	30.5
538 square feet of	4-inch, or	4.0
1,668 square feet of	......, or	12.5

13,017 square feet.

Jean Bart.

2,636 square feet of	10.3-inch, or	22.0
5,972 square feet of	7.2-inch, or	51.0
3,326 square feet of	......., or	27.0

11,934 square feet.

Wyoming.

1,829 square feet of	11-inch, or	16.0
3,272 square feet of	10-inch, or	29.0
967 square feet of	6.6-inch, or	8.0
5,380 square feet of	......, or	47.0

11,448 square feet.

Sebastopol.

3,658 square feet of	8.7-inch, or	31.5
5,972 square feet of	6.0-inch, or	51.5
1,076 square feet of	3.0-inch, or	9.0
915 square feet of	....., or	8.0

11,621 square feet.

From an inspection of these tables we find that the Russian and Argentine ships conform more closely than the others to the modern idea of having a great portion of the side protected by armor. In fact, even if we should consider as unprotected the parts covered by 4-inch ar less, there would still remain in these two types some 83 per cent. armored with 6-inch or over. Of this 83 per cent., however, the Argentines have three-eighths of 6-inch and five-eighths of 8-inch or better; while for the Russians the figures are just the reverse. While admitting that the South Americans are very well protected, it must be said that the 12-inch covers a very limited zone.

As to the protection of the French and the American vessels, the latter are indeed somewhat the better off in this respect, but still not the equal of the Argentines.

Until the time comes when all nations shall have adopted a uniform projectile against which but one kind of armor shall be used, we think the French idea seems rational; that is, one thickness for protection against armor-piercing projectiles and another for defense against common shell.

The turrets of the Americans are (probably only the face plates) 11 inches thick; 10½-inch for the French; 9-inch for the Argentines; and only 8-inch for the Russians. The latter's conning towers are 11 inches, against 12 in the others. The *Rivadavias* have 1½ inches (38 millimeters) on their funnel casings for a height of about 16 feet above the main deck: we doubt the efficiency of such thin armor.

HORIZONTAL PROTECTION

The Argentine battleships are said to have two protective decks—one of 1½ inches, which is probably the main deck (except at the stern, where it would be the gun deck) and another deck below, which is 3 inches (75 millimeters) thick.

Regarding the American ships, the *Scientific American* says that there is only one protective deck, 2 inches thick. In the wake of the magazines, however, there is another of the same thickness.

France, the country of aeroplanes and dirigibles, has, according to the *Moniteur de la Flotte*, given her ships three armored decks. The uppermost of these is of 1.2-inch (30-millimeter) steel; the middle one of 1.95-inch (48-millimeter); and the lowest of 2.78-inch (70-millimeter). Aside from the fact that it is difficult to guess just where these decks are located, it would seem a bit premature at this time to trouble about explosives hurled from above; and M. Lyasse is too able an engineer to waste so much tonnage on over-heavy protective decks.

Engineering makes no mention of the deck armor of the Russian vessels.

UNDER-WATER PROTECTION

The problem of protecting the under-water bodies of these four types of dreadnoughts has been attacked by the various designers in divers ways. The Argentines have devoted 670 tons of steel to internal protection, in the shape of armored bulkheads an inch thick and some 10 to 13 feet inboard from the vessel's sides; and also in 0.7-inch (18-millimeter) plates under the engines and magazines.

The French had a rather unhappy experience with a caisson built at Lorient on the model of the *Mirabeaus*, which led to an acrimonius discussion in the Board of Inquiry as to the waste of 2,700,000 francs ($521,000) on each of the six *Dantons*. Therefore in these later ships they have abandoned completely the idea of armored protection against submarine attack. The Russians also have given it up.

SPEED

In the matter of speed we find adherents of two schools. The Russians and Argentines belong to one, the French and Americans to the other. The *Rivadavias* are to have 23 knots' speed with 42,000 horse-power; the *Sebastopols* 40,000 horse-power is to drive them at 22.5 knots. The Americans and the Frenchmen are most modest, being contented with 20.5 and 20 knots, respectively, with 28,000 horse-power each.

It is rather remarkable that the American *Delaware* and *North Dakota*, designed in 1907, were given 21 knots' speed, which wes reduced in the *Florida* and *Utah* to 20.75; and now, as we have seen, the *Wyomings* are to have even ¼ knot less. This looks like a premeditated sacrifice, but it should be remembered that the contract speed is to be attained with 1,964 tons of coal on board.

Engineering, in a somewhat unfavorable criticism of the Russian ships, finds these 23 knots totally unnecessary. This is one of the most fruitful fields of dispute among naval architects, and it shows little likelihood of dying out One thing seems certain—the increase in the speed of battleships is slow but sure, and all must come to 23 knots sooner or later. Therefore those navies which build few ships must keep a step or two in advance, so as not to be left behind in the race for supremacy. There is no doubt but what the Russians might have saved 2,000 tons of displacement, and the Argentines at least 3,000, by contenting themselves with the speed of the *Wyoming* or *Jean Bart*.

COAL CAPACITY

The Argentines have inaugurated a new departure, in that they have given their ships a coal capacity proportionate to their displacement. This seems logical enough; but all the nations have hitherto followed the example of England, who had given the original *Dreadnought*, and even the *Neptune* of 20,000 tons, the same normal coal supply (900) as had the old *Duncan* of only 14,000 tons displacement.

The French have clung to the "normal" 900 tons, with a maximum of 2,700, as in the *Patrie* class. The Americans (2,500 tons coal and 400 oil) have hardly improved in this respect over the *New Hampshire;* the increased amount of coal carried by the *Wyoming* on the trial trip merely resulting in a greater draft and a correspondingly reduced speed.

The Argentines, on the other hand, have adopted a bunker capacity of hitherto unheard-of magnitude; their normal supply being 1,600 tons out of a total of 4,000 tons of coal and 660 of oil fuel. We need not dwell on the immense advantage this gives the South American vessels, but we call the reader's attention to the necessity for wide radius of action in ships of a nation bordering on the ocean. On the other hand, those which like the Austrian *Radetskys* (14,500 tons, 1,350 tons coal) are less well supplied with fuel, are not therefore to be considered inferior in design, but rather the more fortunate in belonging to a navy which operates in the confined waters of the Mediterranean.

DISPLACEMENT

To make a fair comparison of the displacements of the various types we must first put them all in the same condition with regard to coal, etc. In France they consider the normal coal supply one-third of the maximum; in Argentina, 40 per cent.; and in the United States, two-thirds, besides two-thirds of the oil fuel.

Taking one-third of the maximum as the normal in each case, we find the several displacements somewhat as follows:

*Rivadavia**	27,533 tons (with 1,333 tons of coal)
Wyoming	25,298 tons (with 845 tons of coal)
Jean Bart	23,323 tons (with 900 tons of coal)

As we do not know the coal capacity of the *Sebastopol*, we shall take the displacement given in *Engineering*, which is 23,000 tons.

The fact that the Argentines displace 2,235 tons more than the Americans can be accounted for when one considers that the extra 12,000 horse-power weighs 800 or 900 tons; and the 670 tons of under-water armor and 500 tons more of coal not only account for the rest of this discrepancy, but prove either that the Argentines are far more economically designed or that the American plans nar needlessly extravagant. At any rate, it is apparent that the South American ships are better protected (their armor weighs 7,500 tons to 6,924 tons for the *Wyomings*); and have the advantage of a topgallant forecastle with a main deck redoubt, which latter, in spite of the loftiness of the *Wyoming's* decks, gives the former an average of about 20 inches more freeboard.

---

* The various ships all carry about the same amount of ammunition. The *Jean Bart* has a normal supply of 100 rounds per 12-inch gun and 275 for each 5.5-inch; the *Rivadavia* carries normally 80 rounds for the big guns (but with magazine capacity for 120), 300 6-inch and 850 4-inch; the Americans carry the same number, at least for the 12's. About 144 tons of the *Jean Bart's* displacement are accounted for by the greater weight of her 12-inch shells (968 pounds) and powder charges (350 pounds).

Wherefore it may be said with some degree of assurance that had the United States ships been designed with the same skill as the Argentines, they would have had from two to three thousand tons less displacement. We may draw similar conclusions from the comparison between the *Wyoming* and the *Jean Bart*, which have about the same speed, freeboard, and protection, while the latter's twenty-two 5.5-inch guns certainly outweigh the American's twenty-one 5's.

As for the Russians, it looks as if the utmost possible had been accomplished on a moderate tonnage. The three-gun turrets show some economy (about 300 or 400 tons, with the barbettes all on the same level); but their low freeboard and relatively thin armor do not quite explain how they get 23 knots on a displacement of only 23,000 tons. Nevertheless, the hulls seem to have been designed so as to give, if not robustdess, at least lightness and rigidity.

DIMENSIONS

In giving the draft of the several vessels we shall take the normal displacement as given in the preceding table. The lengths cited below are fairly accurate, and refer to the distance between perpendiculars, after the English fashion.

	Length Between Perpendiculars.	Breadth.		Draft.	
	Ft.	Ft.	In.	Ft.	In.
Rivadavia	604	96	..	26	9
Wyoming	540	93	3	27	6
Jean Bart	541	88	7	29	..
Sebastopol	566	89	..	27	3

Granting the inestimable value of moderate draft, we must concede that the Argentines have solved the problem brilliantly; but to make the comparison thoroughly fair, let us expand all foru displacements to a common unit (that of the *Rivadavia*) and see what the result will be. Note that the dimensions have been altered according to the laws of similitude.

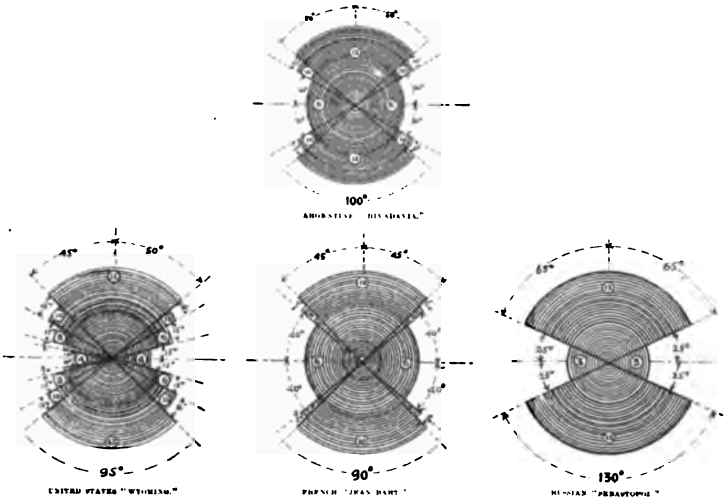
		Length Between Perpendiculars.	Breadth.		Draft.	
		Ft.	Ft.	In.	Ft.	In.
Rivadavia		604	96	..	26	9
Wyoming	Raised to 27,533 tons	554	96	2	28	4
Jean Bart		574	93	10	30	8
Sebastopol		601	94	2	29	..

Thus we see that, as was to be expected, the two fastest types have the greatest length; the Americans are shortest and broadest; while the Frenchmen draw the most water, and this is perhaps their worst defect.

SUMMARY

The opinions expressed herein were of necessity more or less subjective, although after closely studying the four types of dreadnoughts some few conclusions are sufficiently evident to make their acceptance a matter of course. The French ships are palpably inferior to the others in offensive force, while the Russian disposition of armament far outclasses the others. The advantages of an arc of maximum efficiency of 130 degrees are so enormous that we must hand them the palm, no matter what defects we may think we see in their triple turrets. The adversaries of this arrangement of guns make the most of two drawbacks, viz.: "Too many eggs in one basket" and weakness in fore-and-aft gun fire.

Concerning the first disadvantage, it may be said in rebuttal that the Russians have obtained an unusually large amount of independence for the individual turrets, which are located in four widely separated parts of the ship, 116 feet between centers. With the turrets superposed, or placed close to one another, as in the other three designs, there is always an excellent chance for one lucky shot to disable a great proportion of the armament. From this point of view it looks as if the Russians had put their study to the best account.



DIAGRAMS SHOWING ARCS AND CONCENTRATION OF FIRE OF 12-INCH GUNS

Figures in circles show number of guns that can be concentrated within the respective shaded areas of fire

To realize, on the other hand, of how little importance is the sacrifice of end-on fire, one need but to examine the diagrams of the most important battles of the late Russo-Japanese war.

For the two battles of the 10th of August, 1904, we quote the official Japanese reports. In the first action, which lasted some 125 minutes, from 1:15 till 3:20 p.m., the duration of time in which the volume of fire of the Japanese was at its minimum was only 8 minutes, as against 117 minutes during which their ships were able to show their greatest offensive fire. These figures were respectively 20 and 105 minutes for the Russian squadron. Both sides, then, were able to concentrate their maximum gunfire for about 90 per cent. of the action. In the second encounter, which began at 6:15 p.m. and ended at 7:10 —or about 55 minutes—both the Japanese and the Russians maneuvered their vessels so as at all times to present to one another their greatest arcs of fire.

For the details of the battle of Tsushima we are indebted to the diagram and description of the American naval officer White, which, taking it all in all, has remained one of the most reliable commentaries on that battle. The fight lasted from 1:55 in the afternoon until 4:15, some 140 minutes. During this action the Japanese fired end-on for a little less than 15 minutes, the Russians for as much as 30. All the rest of the time the ships were broadside to each other.

Rear-Admiral Wainwright, U.S.N., was altogether right when he said that the greater part of every sea fight would take place with the ships firing between the angles of 45 and 135 degrees from the bow; and that a fair percentage of the remainder of the time would see the firing between 20 and 45 degrees and 135 and 160 degrees; with the negligible balance for end-on fire.

It would appear from actual experience in the Russo-Japanese war that this minimum is fixed at between 10 and 15 per cent. Now, does it seem worth while to sacrifice two guns (as the French have done) for 85 per cent. of a battle in order to have two more for 15 per cent of the time? And have not the Argentines themselves sacrificed some 30 degrees of their arc of maximum offense in order to increase their actual fore-and-aft fire by two guns?

As for the Americans, we cannot understand why they did not go further and adopt what looks like the best plan of all. We refer to the suggestions of Lieut. De Feo of the Italian navy, for it was he who first called attention to the merits and strong points of that method of solving the question of systematization of artillery. (*Cf. Rivista Marittima*, March, 1906.)

Altogether, we think the Russians scheme by all means the best, and the French system the least good of all the four types under consideration. On the other hand, we think the Russian disposition of the torpedo-defense guns very inferior, while the French have easily excelled in this, barring always the four guns in the stern. In the matter of protection the Argentines rank first and the Russians last; but the differences are not very vital.

From a technical point of view there is little doubt but that the Russians have succeeded most happily in combining with intelligence the elements of great gun-power, good protection, and high speed on a very modest displacement; among the rest we think the least successful have been the Americans.

But to anyone familiar with the internal workings of the United States Navy Department this will cause little surprise, nor prove difficult to explain.* And indeed the large margin of safety and general habitability inherent in these ships compensate in a way for the many apparent extravagances of their design.

In conclusion, be it said, each of the four types which we have examined presents in itself some noteworthy departures, the study of which must needs prove profitable notwithstanding the constantly changing aspect of naval construction from year to year.

—*Scientific American Supplement*, December 31, 1910.

---

* "Hearings on the proposed Navy (Re) organization," 1910, pp. 463, etc.

EROSION AND BALLISTICS: A REJOINDER

By PROFESSOR PHILLIP R. ALGER, U. S. Navy

In the article just preceding this,* certain objections are made to a theory of the cause of gun erosion set forth by the present writer in the last number of the *Proceedings*, and a number of questions are asked with the intention of illustrating our ignorance of what really happens when a gun is fired. Without pretending to answer all the questions completely and with certainty, I am led to attempt an answer to some of them because they are of great interest to all who are concerned with ordnance—one in particular regarding the cause of the bursting of guns of vital importance.

Taking up first the objection made to my theory of erosion (I call it *my* theory merely for brevity) on the ground that the charge is distributed along the bore as the projectile moves, so that more hot gas passes over a point well down the bore than over a point near the origin of the rifling where erosion is greatest. The fact that the pressure gauges put loosely in the bottom of the chamber of a gun are almost always found remaining there after the gun is fired lends some color to my view that the bulk of the powder charge always stays in the chamber. But independent of that, it is not necessary to assume that the movement of the gases rubs off the softened metal; it may merely be that the motion of the gases over the surface is necessary to allow enough heat to be transmitted to the metal to melt it away. It is well known that the transfer of heat from a gas to a metallic surface is greatly assisted by movement of the gas, the reason being that a film of partially cooled gas adheres to the surface and impedes the conduction of heat; rapid motion of the gas tears this film away. Furthermore, it has been found that a large part of the heat transmitted by hot gas to a metal in contact with it comes from radiation,† and perhaps this explains why the quantity of heat as well as the temperature plays a large part in the heating of the gun wall. The bore at the origin of rifling is exposed to the radiation of heat from the powder gases longer than portions of the bore nearer the muzzle and so receives more heat than they do.

However all this may be, it seems to me quite certain that the ignition charges of the front sections of the powder charge cannot play any part in distributing the grains of powder along the bore. Since the projectile cannot move until there is enough pressure on its base to force its rotating band into the rifling (2 tons per square inch or more), not only must all the ignition powder have been inflamed but every grain of the charge must be burning fiercely before the projectile starts. The temperature in the powder chamber when the projectile begins to move must be in the neighborhood of 2000 °C.

As for the argument that gases moving *behind* the projectile would erode grooves as much as lands—the explanation of the fact that they do not is simply that the lands, projecting into the hot gases, are more easily heated than are the bottoms of the grooves.

---

* The article here referred to is a reply by Lieut.-Commander H. C. Yarnell to Prof. Alger's criticism of Lieut.-Commander Yarnell's article on "Gun Erosion" which appeared in the *Journal of the American Society of Naval Engineers* for May, 1910. Lack of space prevented the reproduction of Lieutenant-Commander Yarnell's reply. In it he emphasizes particularly our lack of knowledge of various factors in the problem,—the pressure at which the projectile starts, the form of the pressure curve, the effect of pressure on rate of combustion, the actual stresses to which the walls of the gun are subjected, etc.

Lieutenant-Commander Yarnell's original article was reprinted in the JOURNAL for September-October, 1910. Prof. Alger's criticism upon it will be found in the JOURNAL for November-December, 1910.—EDITOR.

† See a recent report of the Gaseous Explosions Committee of the British Association for the Advancement of Science.

In considering the question of the efficiency of our present rotating bands in the matter of preventing the escape of gas, it must be remembered that the time of action is extremely small, so that the difficulty is much less than it would be if the pressure were a sustained one. It is true that we cannot "positively state that the rotating band offers a nearly perfect seal against the escape of a gas whose pressure is 40,000 pounds;" yet it is still my opinion that such is the case. If any gas does get through the close metal contact (nearly 4 inches long in a 12-inch gun), it must, I think, lose practically all its heat in doing so.

To answer the question at what pressure does the projectile start to move, we have the results of extensive experiments made at the Watertown Arsenal and reported in various volumes of *Tests of Metals*. The actual force required to push a projectile through the bore was measured for guns from the small arm to the 12-inch rifle, and while it is probable that the quicker action, as well as the expansion of the bore by the powder pressure, will make the required force less in a fired gun, we certainly can feel sure of having its value in the latter case within reasonable limits. Roughly speaking, it takes about two tons per square inch to start a large caliber projectile,—more for the smaller calibers,—and the force required to overcome the resistances of friction and forcing reduce to something less than one ton per square inch as the muzzle is approached.

As to the form of the pressure curve in a gun:—We know the maximum pressure by measurement with the crusher gauge, the reading of which should be increased about 8 per cent. to allow for the fact that the coppers offer greater resistance to crushing in a gun than they do in in a testing machine.* We know the pressure near the muzzle by measurement of the velocities given by the same charge in guns of different lengths. And we know the area under the pressure curve, since it must be equal to the total work of the powder charge in the gun. From these data we can certainly construct a pressure-space curve of reasonable accuracy.

The pressure action on a gauge in a gun does not change from static to dynamic at any *point in a gun;* it changes gradually from one to the other, being wholly static in the chamber and practically wholly dynamic near the muzzle where the time taken to expose the gauge to the action of the pressure is reduced to a few hundred-thousandths of a second.

Vieille's experiments have shown that ether-alcohol colloids of gun cotton, such as our smokeless powder, burn with a velocity proportional to about the two-thirds power of the pressure. Some writers on interior ballistics have attempted to discredit this value and have adopted unity as the exponent of the pressure, but the fact that their mathematical calculations are greatly facilitated by substituting one for two-thirds explains their preference for the former quantity. Here we have a real case of facts being forced to yield to theory.

In regard to the velocities used in the tests of the Crozier and Brown wire-wound 6-inch guns, I find that the actual average velocity of the 98 rounds fired was 3231 f.s. There were only 18 rounds at 3400 f.s. and above;

---

* See appended translation of *The Influence of Velocity on the Law of Deformation of Metals, by P. Vieille and R. Liouville* (Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences, May 14, 1906); also of *On a Method of Measuring the Resistance of Metals to Rapid Deformations*, by the same authors (Comptes Rendus, etc., Dec. 31, 1906).

[These translations are not reproduced here, for lack of space.—Editor, Journal.]

11 at 3500 f.s. and above; 7 at 3600 f.s. and above; 5 at 3700 f.s. and above; and 1 at over 3800 f.s. These are the true figures for the Crozier gun (those for the Brown gun are practically the same), and they fully justify my original statement that 3600 f.s. was *considerably* greater than the average velocity.

We now come to the most important question requiring answer. Why, if we really know what the pressure is and if our theory of the strength of guns is correct, do our guns sometimes burst? This question I propose to answer at some length, first taking up a theory of the strength of guns and cylinders which, if accepted, would be a sufficient explanation of our gun accidents.

This theory, advanced by Professor C. A. M. Smith in an article in *Engineering*, is interesting, but fortunately can be disproved. It rests upon the assumption that what is known as Guest's law applies to gun steel. Guest's law, so called, is that failure occurs when the maximum shear stress at any point exceeds the resistance of the material to simple shear, this latter being one-half the resistance to simple tension. In designing our guns and calculating their strength we assume that failure will not occur until the maximum *strain* at some point exceeds the allowable strain in simple tension. Upon the first theory the strength of a gun is only about half what it is upon the second theory. That guns do not burst whenever they are fired is explained by Professor Smith as probably due to the short time of action of the pressure.

Now in the first place, in modern guns, the time during which the maximum pressure acts is very much greater than it was in the days of smooth bores and black powder. In our 12-inch 45-caliber gun, for instance, it takes a little more than one hundredth of a second for the pressure to rise from about 2 tons per square inch (when the projectile begins to move) to its maximum of say 17 tons per square inch, and about an equal time to decline to its muzzle value of 5 or 6 tons per square inch. This, in view of the enormous speed at which elastic vibrations are transmitted through steel, would seem ample to cause rupture, if the pressure applied really greatly exceeds the resistance of the gun.

In the second place, in such tests of thick cylinders as have been made within my knowledge, the interior pressure required to produce permanent expansion and that required to produce rupture have been fully equal to the pressures calculated by the maximum-strain theory as necessary to cause the metal to reach its elastic limit and tensile strength respectively.

For example, a 6-inch gun jacket (17″.25 outside and 11″.75 inside diameter) tested to destruction, in 1901, at the Indian Head Proving Ground, by exploding charges of smokeless powder within it, its ends being closed by heavy steel caps, stood pressures up to 7.5 tons per square inch before it showed any permanent enlargement and only burst under a pressure of 13.4 tons per square inch. The elastic limit of the steel in this jacket was about 22.5 tons and its tensile strength about 40 tons per square inch. According to Professor Smith's theory the elastic resistance of this jacket should have been reached with a pressure of about 5.5 tons and its ultimate strength with a pressure of about 10 tons. According to our maximum strain-theory the figures should have been 7.3 tons and 13.0 tons respectively. And again, a 5-inch gun jacket was tested with hydraulic pressure at the Watertown Arsenal in 1906. Its diameter inside was 5″.08 and outside 8″.15; its length 18″.5; pressure applied by forcing into it a piston of the same diameter as the bore, the other end being closed by a plug, so that the ends were free and there was no longitudinal stress. The first yield was at a pressure of 24,960 lbs. per square inch, when the tangential true stress (total strain times modulus of elasticity) was 65,000 lbs. per square inch; the greatest pressure applied was 30,720, giving a tangential true stress of 80,000, beyond which it was found impracticable to keep the hydraulic packings tight. According to Professor Smith's theory the elastic limit should have been reached at a pressure of 17,500 lbs. per square inch.

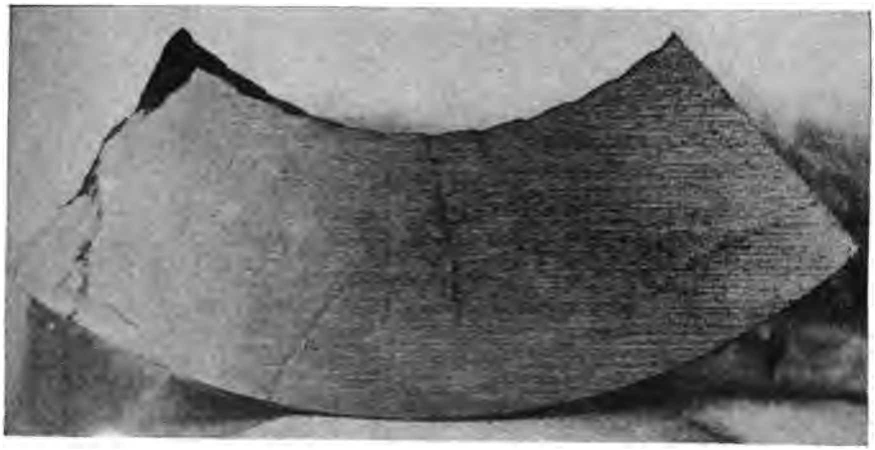
Finally, and I think conclusively, the bores of guns after repeated firing are found upon examination (after the jackets and hoops have been removed) to be in a state of circumferential *tension;* whereas, if the gun were overstrained by firing, the inner surface of its tube (when free from the compression of jackets and hoops) would be found to be in a state of circumferential *compression*. This may be demonstrated by trepanning from the bore of an old gun a thin ring of metal; if such a ring is cut through on an element, it will be found to close in on itself, not to open out. Or, if a section of such a gun tube be put in a lathe and turned down on the outside, its bore will be found to contract, the removal of the outer metal gradually freeing the inner metal from its state of tension and allowing it to shorten. If Professor Smith's idea were correct that "before the gun actually bursts the metal has graded itself off into material which, at the inner surface of the gun, has been very much overstrained, and on the outside of the gun is a little beyond the elastic breakdown of the material," it is evident that the inner surface of the gun tube (when freed from the compression of jackets and hoop, and at rest) would be in a state of *compression* circumferentially and, if freed from the outer metal of the tube, would expand. *The fact that it contracts when so freed proves that the pressures to which it was subjected in firing have not overstrained it.*

The explanation of the actual state of tension of the bores of guns after use is supposed to be as follows: At each discharge the metal at the surface of the bore is heated to a temperature that would cause it, if free, to expand a great deal more than it can stretch within its elastic limit; its free expansion being prevented by the outer metal (which remains cool), it takes a permanent set in compression, or, in other words, is crushed; then, when it cools, it is held in a state of tension by the outer metal.* (Or, in the case of a built up gun, it is less compressed than it was.) The result is that the surface of the bore more and more assumes a state of circumferential tension, and ends by developing longitudinal cracks (which we call heat cracks). These cracks appear at the bottoms of the grooves of the rifling (at the roots of the driving edges of the lands when the grooves are hook shaped and at both corners of square sectioned grooves), and they work further and further into the metal as the use of the gun continues, finally becoming deep enough to seriously reduce the strength of the gun. Thus, for example, a ring cut from the tube of an army 12-inch gun without boring to remove the rifling burst with no stretch under a hydraulic pressure less than half that which another ring adjoining the first (but bored out) stood,—the second ring stretching 11.5 per cent. without rupturing. And, again, army 8-inch B.L.R. No. 1, after firing 388 rounds, was taken apart for examination and it was then found that its tube was cracked through in two places and that the chase hoops, which alone prevented the gun's bursting, were stained on the inside with powder gases that escaped through the cracks each time the gun was fired.

---

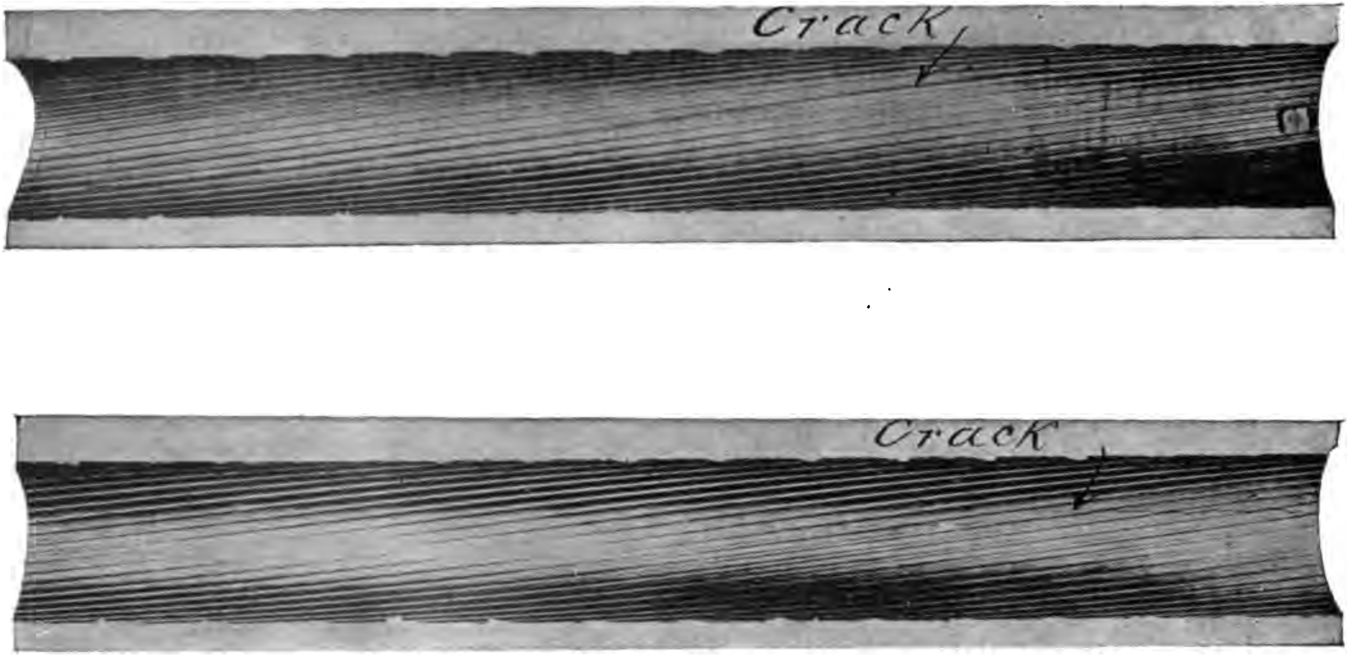
* This action can perhaps be made clear by the following illustration. If a block of metal, say a short cylinder, is fitted tightly between two immovable plates and then heated, it will be found, when cooled again, to fit loosely, so that it will be necessary to stretch it to restore its original length; being unable to expand when heated, it has crushed itself.

The heat expansion corresponding to 250 °F. is about equal to the extension of gun steel at its elastic limit.



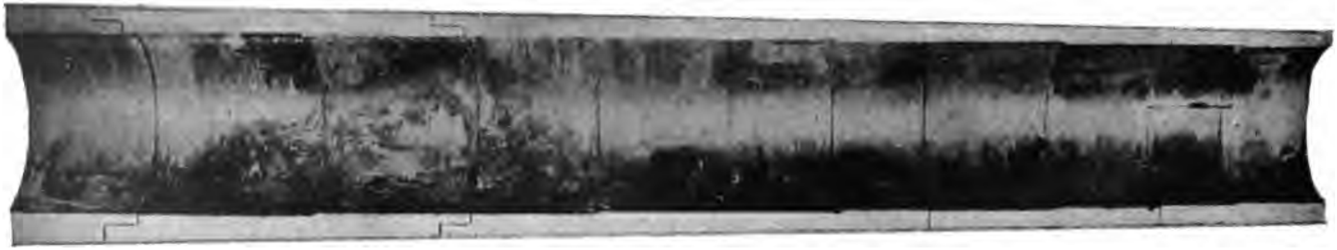
Proceedings of the U. S. Naval Institute

U. S. NAVY 12-INCH, NO. 16, BURST AT INDIAN HEAD, FEBRUARY 9, 1906.
SECTION OF TUBE SHOWING HEAT CRACKS AT BOTTOMS OF GROOVES.
CRACKS *a* AND *b* PRODUCED WHEN THE GUN BURST



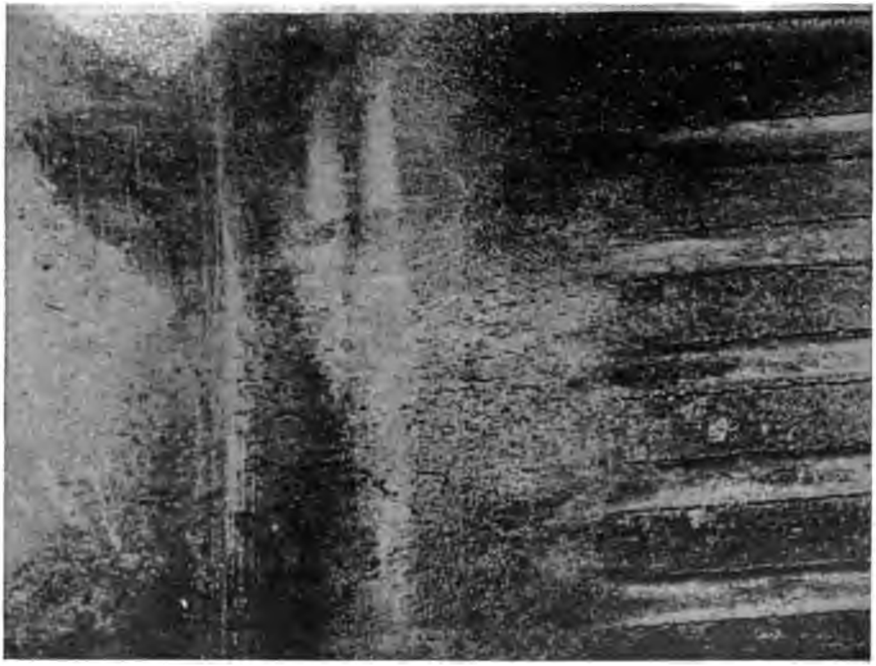
Proceedings of the U. S. Naval Institute

U. S. ARMY 8-INCH, NO. 1, AFTER 388 ROUNDS. RIGHT AND LEFT HALVES OF TUBE SHOWING THROUGH CRACKS



Proceedings of the U. S. Naval Institute

U. S. Army 8-Inch, No. 1, After 388 Rounds. Interior of Chase Hoops Showing Escape of Gas Through Crack in Tube of Gun



Proceedings of the U. S. Naval Institute

U. S. ARMY 5-INCH. ORIGIN OF RIFLING, ENLARGED. SHOWING HEAT CRACKS AT BOTH CORNERS OF SQUARE SECTIONED GROOVES

This is the answer to the question why certain of our guns have burst along the chase. The strength of these guns as designed and built, even though they were not hooped to the muzzle, was ample to resist the pressures developed by the normal action of the powder charge. When the first one burst there was a choice of two theories to explain it,—either the powder or the gun was at fault. As the metal when tested proved good, the blame was laid on the powder, which was thought to have burned abnormally and given rise to an excessive pressure at the muzzle. Other guns burst and in no case did the metal of the gun show any sign of being defective. Then it was noted that there had been a tendency to make powder slower, so that very large charges were being used to give the standard velocity, and it was thought that the result might be higher muzzle pressures than the guns could stand. But tests at the proving ground showed that even with the slowest powders the muzzle pressures were within the calculated elastic strength of the guns. Of course the theory that guns are weakened by crystallization of the metal due to the shock and vibration of repeated firings was not overlooked, but no reasonable justification could be found for such a far fetched theory.*

Finally, some two years ago, the existence of heat cracks in guns was discovered at the Watertown Arsenal,† and all was explained. Guns are weakened by continual use, though the metal itself is not altered,—a factor of safety quite sufficient when the gun is new ceases to be so after the gun has become old. Hooping all the way to the muzzle is necessary to provide sufficient strength even after the tube has been weakened by the development of heat cracks. The advantage of having an inner tube or liner, before not seen, became apparent, its effect being to limit the extension of cracks and thus to prevent the actual bursting of the gun even in the event of a high pressure causing a crack to extend through the liner.

In corroboration of this statement, see the Report of the Chief of Ordnance, U. S. Army, 1909, in which General Crozier says: "During the past few years the department has not been free from the occasional failures of heavy guns, which are believed to have been met with in all services, under powder pressures below those corresponding to the elastic strength of the pieces. A thorough study of the guns that failed and the experience of the department in connection with the manufacture of forgings and their assembling into built up guns indicate conclusively that the trouble arises not from defect in the design of the cannon, but from either concealed defects in the forgings or the development of thermal or heat cracks. . . . These cracks are due to the high temperature of the powder gases, and increase in depth and number as the number of rounds fired increases, though the increase is more rapid in some guns than in others fired under the same conditions. . . . To the prevalence of these cracks and the accompanying brittle condition of the metal of the surface of the bore, the department attaches great importance.

---

* In 1883, or thereabouts, when Captain Sicard, then Chief of the Bureau of Ordnance, proposed to build wire-wound guns for the Navy, a test of this theory was made at the Washington Navy Yard as follows:

Heavy weights, sufficient to strain the wire nearly to its elastic limit, were suspended by pieces of the wire intended for use on the guns, and small hammers were arranged so that, actuated by the machinery of the shop, they struck the taut wires at regular and frequent intervals. After months of constant vibration, all the time under severe strain, the wires, when tested, showed unchanged physical qualities. Moreover, every gun, army and navy, that has suffered accident, since we first began to build steel guns, has had the metal of the part that failed tested, and never has there been a case when any material difference was found between the physical qualities shown by the last tests and those shown by the original tests for acceptance. One of these guns, a 12-inch, had been fired 481 rounds when its muzzle was blown off.

† For a very complete and interesting study of the metal of the tube of an army 12-inch gun that burst in 1907, see "*Tests of Metals, 1908.*"

and has decided to reline guns as soon as these thermal cracks become very pronounced, instead of waiting until the accuracy life of the gun has been reached, due to erosion and wear. All seacoast guns of 6-inch caliber and over, except mortars, manufactured hereafter will be provided with double tubes, so that if, from defective material or thermal cracks, the inner tube gives way, the damage will not extend to the outer tube and the enveloping jacket and hoops."

A recent article in *Engineering* puts the blame for accidents to our guns on the form of powder grain that we use, the multi-perforated cylinder, but the powder has nothing to do with it, excepting to the extent that we give our guns harder usage than any other navy. The twenty rounds, all full charges, that we fire annually from each 12-inch gun is much more, I believe, than any other navy fires.* Unfortunately it is the gun itself that is at fault, and the only remedy so far as yet known is to construct guns having a greater factor of safety along the chase than our earlier models and to reline all guns after they have fired a certain number of rounds.

A final point in regard to which it is said that theory does not agree with practice is the drift of projectiles. Now when theory seems at variance with facts it must not be overlooked that an error in the facts, or a misinterpretation of them, will explain the discrepancy just as well as an error in the theory. Too often a correct theory is condemned because it does not accord with alleged facts that really are not facts. Moreover, facts in themselves are of little value; it is the conclusions that are drawn from them that are, or may be, valuable, and errors of reasoning are just as likely to creep in here as at an earlier stage.

In this particular case, observations of drift made on certain ships, one in particular, gave results greatly different from those calculated by the well known Gâvre formula ($D = KV^2 \sin^2 a$) using a particular value of the constant ($K = .0025$), and it was concluded that the formula was wrong,—not that the value of the constant was wrong, which may very well be true, but that the formula was wrong. On other ships the measured drifts agreed very closely with their calculated values, and that alone should be sufficient to prevent condemning the formula until less doubtful facts could be brought against it. But independent of this, experience shows that drift at long ranges is so greatly affected by conditions which escape observation (such as wind, which may be quite different at an altitude from what it is at the sea level), that the determination of it by a few rounds on one occasion is of no value. As a matter of fact, after years of experiment at Indian Head, we are unable to give anything but a very rough approximate value to the drift. After examining all the records and testing various formulæ with them, I am of opinion that the Gâvre formula is about as good as any other, though the value of the constant seems to be somewhat less than stated in my Exterior Ballistics (about .0016 for the old form of projectile and somewhat more for the new form). The formula $D = kX \sin a$, (D = drift; X = range; a = angle of departure; k = constant), recently proposed by Lieut. P. Bertagna, Italian Navy (*Rivista Marittima*, Oct., 1909), is perhaps a little better than the Gâvre formula for high velocity guns; the formula of Mayevski, Charbonnier and Hamilton are much less simple and no more accurate as far as can be judged from our experimental results.

In conclusion, and returning to the subject of erosion, I have recently learned of experimental results that confirm my belief that measurements of the erosion produced by the escape of powder gas through vents are inconclusive as regards real gun-erosion. Sir Andrew Noble recently stated, in a paper read before the North East Coast Institution of Engineers and Ship-builders, that the British officially promulgated statement that it takes 4 three-quarters, or 16 half charges to produce as much erosion as one full charge is wholly incorrect. His bomb experiments had shown "that the erosion due to 1 three-quarter charge was less than that of a full charge, but that 2 three-quarter charges gave more erosion than 1 full charge; while 2 half charges gave less, but 3 half charges gave more erosion than 1 full charge; or, in other words, that the erosion was a little less than that due to the comparative weight of the charge."

---

* The total allowance for large caliber guns in the British Navy is 16 rounds a year, of which some, and probably the greater part, are reduced charges.

Here is a case where the facts are correct but are misinterpreted,—instead of assuming that his experiments disproved the statement about relative erosions in guns, which in fact is substantially correct, Sir Andrew should have seen that they merely proved the inapplicability of his method of measuring gun erosion.—*United States Naval Institute Proceedings*, December, 1910.

◆ ◆ ◆

CAUSE OF GUN ACCIDENTS

In reply to a letter of Sir Hiram Maxim, in regard to the explosion of guns on American warships, in which the fault is laid to the type of powder grain used by the United States Navy, Secretary Meyer has forwarded to President Taft the statements of Rear Admiral Mason, Chief of the Bureau of Ordnance.

Sir Hiram's letter says, in part:

"Commanding officers have consulted me on the subject, both personally and by letter, and this is the question that they ask, 'Why is it that so many of our guns explode, and no guns seem to explode in Europe?' My reply is always the same. 'Multiple perforated powder.' "

As a basis for his reply, Rear Admiral Mason gives a statement of every injury to naval guns since the introduction of smokeless powder, about the year 1898. Commenting on the reports as to the causes of these accidents he says:

"Not in one case has the evidence of the occurrence shown that the smokeless powder in use at the time of the explosion was at fault in any degree relating to its irregularity or inherent fault.

"These accidents have invariably pointed to one of the following causes: A weakness in the design of the gun, or to the method of assembly, combined with flaws in the metal; to personal mistakes in the weight or selection of the powder charge. The first of these causes appears to be well established, because the accidents have been confined (with one exception, which was due to the method of gun assembly and not to powder) to certain types of guns which have weak chases. Notwithstanding the weak design, it is probable that had these guns been fitted with a liner for the tube, the accidents would not have occurred, because not one gun which was designed for smokeless powder, hooped to the muzzle, had its muzzle injured either in proof, where excessive pressures are used, or in service where service pressures are used.

"The design of the type of guns with weak chases was influenced by the well known pressure curve followed by brown prismatic powder, which had just then been superceded by smokeless powder; the influence of heat cracks in gun metal, at the time of design of these guns, had not been discovered, and it is noteworthy that the guns which have been designed subsequently, with the knowledge of the smokeless powder curves and the knowledge of the influence of the heat cracks, have given no indication of weakness as noted above. The broad statement of Sir Hiram Maxim that the gun accidents of the United States Navy are due to multi-perforated powder grain, therefore, from evidence not at all connected with the detail of the grain, is shown to be untrue."

This is followed by a discussion of the composition of the powder and the details of the grain. The statement shows that 778,070 rounds of service charges have been fired since the introduction of smokeless powder made up with the standard multi-perforated grain; and that these charges were fired under the most varied service conditions, the great majority of them at target practices in tropical climates, during all of which use this fault in the powder has not been felt.

Sir Hiram, in his letter, claims that he was the first to invent multi-perforated powder and that when he learned its dangerous character he gave it up. Rear Admiral Mason shows that the assumption of Sir Hiram as to the type of smokeless powder used in the United States Navy is entirely erroneous.

"The smokeless powder which Sir Hiram Maxim assumes is used in the United States Navy, is in reality a nitro-glycerine compound, but nitroglycerine powder has never been used in the U. S. Navy. It is has been shown that he is ignorant of the type of smokeless powder used by the United States Government, and it is quite probable that he has had very little or no experience with it. In regard to the experiments which Sir Hiram Maxim desires made by firing as rapidly as possible for twenty minutes, in the heaviest gun, the powder to as high a temperature as 'it would be in action in the tropics,' you are informed that similar data has been obtained on many different occasions at the Naval Proving Grounds; it is true, with not the heaviest gun, but by calibers large enough to indicate, without the slightest doubt, the utter lack of foundation of Sir Hiram Maxim's fears. The many target practices of our Fleet in the past, held principally in the tropics, indicate, without any doubt, the serviceable characteristics of our powder.

"It is considered, therefore, unwarranted to carry out further experiments desired by Sir Hiram Maxim and that his statements, in relation to our smokeless powder, are unworthy of serious consideration, except as to their misrepresentations, and to the evil effects of their wide publicity on those unacquainted with this subject."—*The Navy*, January, 1911.

◆ ◆ ◆

SHOOTING IN THE BRITISH NAVY

We have just received the three annually published Blue-books, *Result of Test of Gunlayers with Heavy Guns; Result of Test of Gunlayers with Light Q. F. Guns*, and *Result of Gunlayers Test from Torpedoboat Destroyers*, which show the records made during 1910 in the British Navy. We have been accustomed for some years past to refer to these books and to discuss the improvement made in the shooting of our sailors. This has not always been an easy task, since the conditions have been altered from time to time, so that comparison from year to year becomes impossible. Thus in 1907 a smaller target was introduced, and is still retained, and since no dimensions were given of the two targets, it was exceedingly difficult to form a conception of the relative excellence of the shooting of, say, the years 1906 and 1908. Nevertheless, there was very considerable improvement, as we showed at the time, though it was hard to form a comparative idea of it. This year again there has been another innovation. Hitherto if a shot has hit the water before reaching the target it has been regarded and counted in the returns as a whole hit. In the 1910 returns it only counts as a half hit. Hence the returns of 1910 are not directly comparable with those of the years immediately preceding it.

A noticeable feature of the 1910 returns regarding the heavy guns is the considerably fewer number of rounds fired. There were 117 ships which fired, and the number of guns or turrets concerned was 1318. This is a greater number of guns than in either 1908 or 1909, yet whereas in 1908 9009 rounds, and in 1909 9438 rounds were fired, in 1910 the number was only 7209—an average of some 2000 rounds less, taking the aggregate of the two years and dividing by 2. No explanation of this is given in the Blue-book. The details of the rounds fired, the hits, the misses, and the percentage of the former to the rounds fired for the three years 1907, 1908, 1909, and 1910 are as follows:

	1907	1908	1909	1910
Total rounds fired	9538	9009	9438	7209
Number of hits (direct)	4073	4826	5108	3520
Number of ricochets	—	—	—	436
Number of misses	5465	4183	4330	3253
Percentage of hits to rounds fired	42.70	53.57	54.12	51.85

At first sight it would appear that there had been a set back in the shooting, as evidenced by the fall in the percentage of hits to rounds fired; but if, as in former years, the richochets had been counted in full the figure 51.85 would become 54.86, which shows an improvement of .74 per cent. on 1909. This may not seem very large, but it must be remembered that the standard of 1909 was already very high indeed. The improvement on the results of 1907, the year in which the smaller target was introduced, is very marked.

The analysis of the hits per gun per minute show, in the big guns—12-inch, 10-inch, 9.2-inch, and 7.5-inch—an advance as compared with the year before, and in the case of the 6-inch B. L. and Q. F., the 4.7-inch Q. F., and the 4-inch B. L. and Q. F. guns, a slight falling off. Here again, however, the question of the alteration in scoring ricochets must be borne in mind. The comparative figures of hits per gun per minute for the years 1907, 1908, 1909, and 1910, are as follows:—

	1907	1908	1909	1910
12-inch and 10-inch	.40	.56	.63	.70
9.2-inch	2.01	2.20	1.94	2.01
7.5-inch	1.58	2.51	2.47	2.61
6-inch B. L. and Q. F.	3.32	3.98	4.03	3.69
4.7-inch Q .F. and 4.0-inch B. L. and Q. F.	2.38	3.32	4.06	3.84

In comparing these figures, it will be realised that in 1909 the shooting with the smaller guns was phenomenal.

Turning now to the smaller guns—12-pounders, 6-pounders, and 3-pounders—we find again a very considerable falling off in the number of shots fired, this falling off being entirely out of proportion to the number of guns concerned. The shooting also is not quite so good. The following are the figures for the years 1907, 1908, 1909, and 1910:—

	1907	1908	1909	1910
Number of guns	1,898	1,384	1,407	1,531
Number rounds fired	17,734	12,943	14,276	8,020
Number hits (direct)	7,462	6,120	7,157	3,483
Number ricochets	—	—	—	283
Number misses	10,272	6,823	7,119	4,254
Percentage of hits to rounds fired	42.08	47.28	50.13	45.19

Counting the ricochet as a whole hit, the percentage of hits to rounds fired in 1910 would have been 46.96. This is better than in 1907, but not so good as in 1908 and 1909.

As regards the hits per gun per minute, these would appear to be nearly up to the average, though it is impossible to judge accurately owing to the new way of counting ricochets. The figures for the last four years are as follows:—

	1907	1908	1909	1910
12-pounders	4.471	5.319	6.005	5.454
6- and 3-pounders (except Vickers')	3.640	4.507	4.191	3.651
3-pounder (Vickers')	6.140	6.069	7.810	6.127

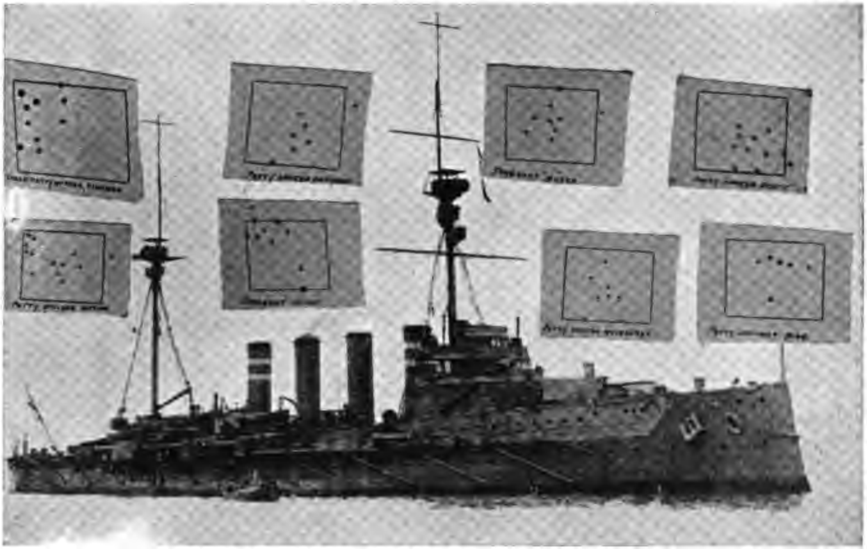
The returns concerning torpedo-boat destroyers have been entirely remodelled, and the very name of the Blue-book has been changed from *Result of Battle Practice from Torpedo-boat Destroyers* to the title given at the commencement of this article. Hence no comparison is possible with former years. Nevertheless, the information given is of considerable interest. The guns concerned are the 4-inch B. L.; the 12-pounder 12 cwt.; the 12-pounder 8 cwt., and the 6-pounder. There were 175 ships engaged in the test, and they had a total of 736 guns. The total number of rounds fired was 3,847, the number of direct hits 1,545, of ricochets 171, and of misses 2,131, the percentage of hits to rounds fired being 42.38 on the average.

The details of the practice made with the various types of guns are given in the following table:—

Nature of gun.	Rounds fired.	Hits.		Misses.	Percentage of hits to rounds fired.
		Direct.	Ricochet.		
4-inch B. L.	140	62	5	73	46.07
12-pounder 12 cwt. on P.V. and V.I. mountings	135	57	9	60	45.56
12-pounder 12 cwt. on P. I. mountings	1052	386	51	615	39.12
12-pounder 8 cwt.	461	125	17	319	29.96
6-pounder, with telescopes	1921	878	82	961	47.84
6-pounder, without telescopes	138	37	7	94	29.35

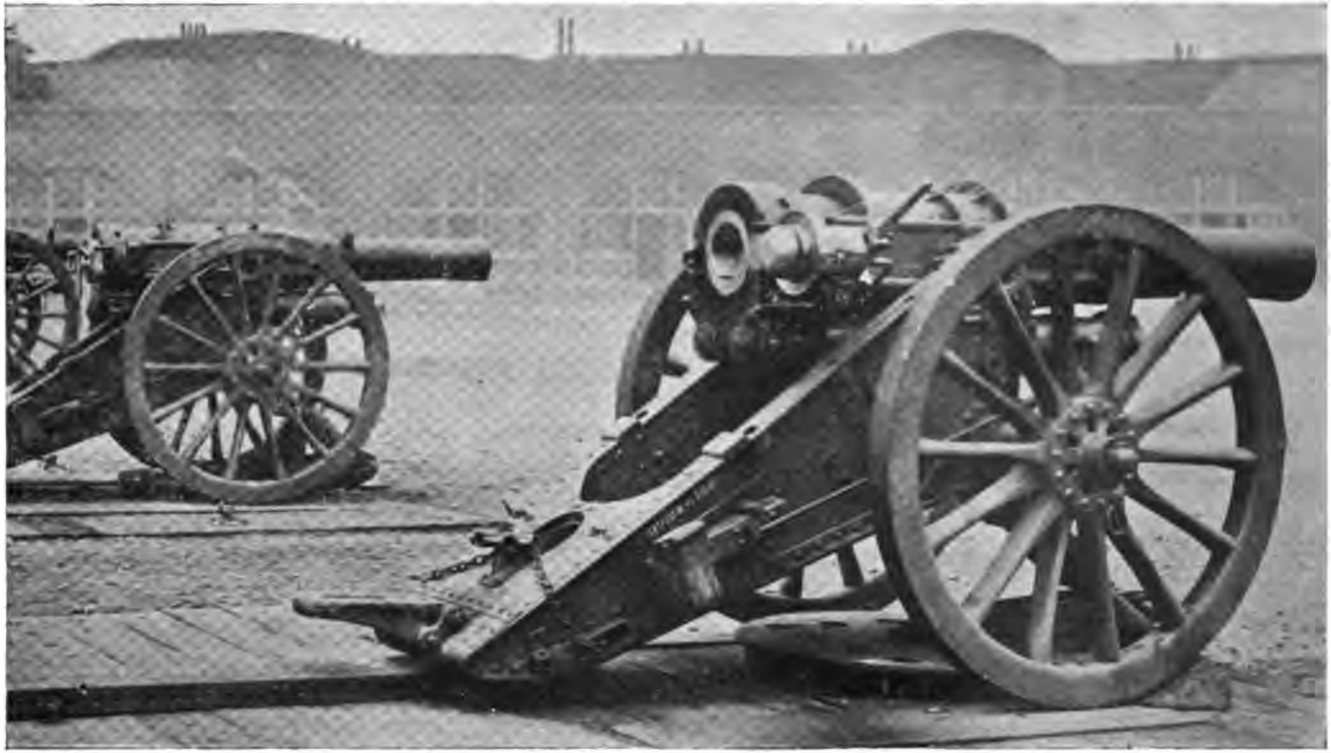
The hits per gun per minute with the 4-inch B. L. gun averaged 3.63, with the 12-pounder 12 cwt. gun 3.88, with the 12-pounder 8 cwt. gun 2.73, and with the 6-pounder 6.43.—*The Engineer*, February 10, 1911.

◆ ◆ ◆



Photograph by Stephen Cribb, Southsea

H. M. Cruiser "Natal" which for the Second Year in Succession Has the Highest Figure of Merit in the British Navy. Score 90.48



Photograph by Stephen Cribb, Southsea

Six-Inch Siege Howitzer, at Grange Fort, Gosport, England, the Depot of the Siege Train, Royal Garrison Artillery

EXPERIMENTS WITH GUNS VERSUS ARMOR (THE KATAHDIN)

The *Katahdin* experiments in long range firing carried out on February 10 near the mouth of the Potomac River continue to be a topic in conversation among the officers of the Army and Navy in Washington, and are everywhere recognized as a very important contribution to the rather limited information which has hitherto been available in connection with the attack of armor under conditions approximating to those of actual battle. This is only one of many directions in which the *Katahdin* experiments are likely to prove of value. They were so planned as to clear up certain points with regard to the flight of the projectiles and the nature of the impact at long ranges, and have given interesting confirmation of the theoretical deductions on these points which have necessarily been relied upon in the past. They indicate, also, that the capped projectiles retain its effectiveness at long ranges, acting at such ranges exactly as in proving ground experiments. The result is the more significant because these firings were with guns of comparatively low power, the velocity of the projectile being only 2400 f.s., as against 2850 given by the twelve-inch guns of recent battleships.

The penetration of the projectiles from the higher power guns at 8,000 yards' range is nearly or quite thirty per cent. greater than that from the guns of the Tallahassee, which it was necessary to use in this test because of the conditions which were needed to ensure safety and accuracy. Although the results so far as accuracy is concerned are of less technical importance than those connected with penetration, they are regarded as very remarkable, the target used having had only about one-third the area of the screens used in target practice. The fact that this target was struck four times in ten shots has surprised even those who were most familiar with the improvements in our ordnance and in the accuracy of fire within the last few years. The experiments have developed several other points which are regarded as of great importance, but which are of such a nature that they will be held confidential. Further experiments will be made during the spring and summer, when conditions of weather make it practicable. The same firing ship and target probably will be used, but the range will be changed to 12,000 yards, or nearly seven miles, and it will be increased or lessened according to the initial results obtained.

Friday, the tenth, was the first day since the *Katahdin* was ready, when weather conditions were such as to make firing of this character practicable. The *Tallahassee*, moored in smooth water near the mouth of the Potomac, fired at the *Katahdin*, placed in shallow water outside at a distance of approximately four and a half miles (over 8,000 yards). The *Katahdin* carried two targets, one twelve feet high by sixteen feet wide, the other twenty feet high by thirty-five feet wide, and made up of armor plates of the most recent type, hard-faced and in thickness varying from eight to eleven inches, some plates being flat and others curved. Ten 970-pound projectiles were fired from the twelve-inch guns of the *Tallahassee* with an initial velocity of 2,400 feet per second. The first two or three shots were sighting shots. One shot struck the eight-inch curved plate of the smaller target and two struck the ten-inch plate, also curved, of the larger target, all penetrating completely. The fourth shot struck the roof of the forward target and glanced off. These very satisfactory tests were planned by Capt. Austin M. Knight, president of the Special Board on Naval Ordnance, and carried out by Comdr. J. V. Chase, commanding officer of the *Tallahassee*, and were witnessed by Major O'Hern, of the Ordnance Department of the Army; Major Hero, of the Artillery; Naval Constructor McBride, U. S. Navy; Mr. Willard G. Isham and the officers of the *Tallahassee*.

It has been decided by the Navy Department to remove from the *Texas* before she is used as a target for the Atlantic Fleet at this spring's practice only such things as can be used in other vessels. Whether the guns with which the *Texas* is equipped will be included in this list has not yet been determined.

Most of the machinery in the *Texas* was placed in her over twelve years ago, and if the ship was to be given a general overhauling would be replaced by new and more modern equipment. It is thought that the old engines and machinery of the *Texas* cannot serve a better purpose than to determine just how much damage projectiles would do to a ship after they have pierced her armor. As a test of the resisting power of armor the experiment with the *Texas* will be practically valueless. It is true she carries 12-inch armor plate, but it has nothing like the resisting power of the plate which has been placed on the battleships of recent construction. Officers at the Navy Department are of the opinion that a very excellent idea of the effectiveness of projectiles in disabling a ship can be obtained by the examination of the condition of machinery of the *Texas* after she has been struck by projectiles. There will probably be some effort also made to determine how disastrous the effect of the modern projectiles upon the crew of the ship would be by placing manikins at stations which would naturally be occupied by the crew.

The most important question to be settled is as to whether the present spotting system used in the Navy is correct. The records of the fleet in recent years in firing at targets indicate that the American gunners would make short work of an enemy in actual warfare. By firing at a vessel it can be decided whether there are any defects in the system of spotting now employed.

The firing at the *Texas* will not be a part of the regular target practice. All of the fleet will not, as has been published, fire at the *Texas*, but the *New Hampshire* has been detailed for this work. It is planned to have this take place before the regular practice, and the work of the *New Hampshire* on the *Texas* will not be included in her target record. The expenses incurred by the Navy Department in this experiment will be paid out of the fund appropriated under the Hobson amendment to last year's Navy bill.

—*Army and Navy Journal*, February 18, 1911.

◆ ◆ ◆

FORTIFICATION OR NEUTRALIZATION (OF THE PANAMA CANAL)

There are two main questions before the country as to the treatment of the Panama Canal. One is as to whether or not it is to be the object of some international agreement providing for its neutralization. The second is as to how the Canal is to be defended, if it be not neutralized by international agreement.

The discussion of the first question reveals two decided differences of opinion. On the one side, those who oppose international agreement for neutralization refer to our treaty obligations and our commercial and military interests as imposing upon us the duty and privilege of retaining and defending the Canal for our own. As opposed to this view, are the often specious arguments of those who would point out that existing treaty obligations may be modified by international agreements to be entered into; by which a group of nations will agree to maintain the neutrality of the Canal. It is perhaps not unfair to believe that expert opinion, both of the military and naval establishments and of the diplomatic world, is almost altogether united in the belief that international neutralization is impracticable; and that inexpert and, to a great extent, sentimental and too altruistic opinion seems to array itself on the side of international neutralization. This opposition to a national canal seems to come from many sources, few, if any, of any definite responsibility.

This first question will probably finally be decided by virtual necessity. Even if we merely neglect, for the time being, to do what we have engaged to do, we will probably be forced, sooner or later, to accept our responsibilities, if we are not so unfortunate as to have them assumed by some other power.

As to the manner in which the Canal is to be defended, the question should be, and is, much clearer. On this score there are two main divisions of expression. There is perhaps really no difference of thoughtful opinion on the subject of how the Canal should be defended. Clearly, the main defense of the Canal should be by adequate fortifications on shore. There is good reason to suspect that of those who faint-heartedly maintain that the navy alone should defend the Canal, a large part are of that party who really wish not to see the Canal defended at all.

The defense of the Canal is not an abstruse strategic problem. The working out of the detail is of course work for experts; but there is no good reason in the world why the Canal should be defended in any other manner than the manner in which every strong power strives to defend its more important or more vulnerable coast points. That method is the method of establishing adequate fortifications on shore—the method that has made Gibraltar the military synonym of strength.

If the Panama Canal, extending from ocean to ocean, with its two entrances, thousands of miles from the country that it is to serve as a strengthening military unit, widely detached from the supplies and resources of that country, can better be defended by a navy than by forts, why cannot we abandon all of our coast fortifications at points more favorably placed, and defend our coast lines—Atlantic and Pacific, Philippines, Alaska, Honolulu—by a navy alone? The people who say that the navy should defend the Panama Canal independently of any fortifications there, *can* know that it is a ridiculous proposal. If they go on insisting upon that proposal, it is only because they *will* not recognize that it is ridiculous.

Assume that the official estimate of twelve million of dollars for fortifications of the Panama Canal is many times too small. Assume that proper fortifications at the Canal and on the outlying islands might cost fifty millions of dollars. That fifty millions would barely provide five battleships. The twelve millions would provide one battleship. The five battleships would offer but a small part of that defense of the Canal which would be insured from year's end to year's end by fifty million dollars spent in fortifications. It takes no expert presentation of this fact to be convincing. It must be evident to anyone who knows enough about the matter to care about it at all. It should be almost equally evident that in cost of maintenance, fortifications would have a great advantage over battleships.

There is another phase of the comparison between fortifications and ships that should not be overlooked. Aside from the great disproportion in first cost and cost of maintenance between forts and ships,—all in favor of forts,—there is probably a still greater relative disproportion in the cost of replacement. It is a well-known and admitted fact that the battleship becomes obsolete in the course of a comparatively few years. Recent history has shown that a battleship ten years old has lost at least fifty per cent. of her comparative fighting strength; and by the time she is fifteen or twenty years old, she becomes practically valueless by comparison with the forces that she would have to meet. There is no cure for this disease. Once a battleship is marked with the signs of old age, a few palliative measures may be taken to make her fit for emergency, if no younger sister serve the purpose, but she rapidly reaches the time when a wise administration will "strike her from the list."

With the shore fortifications the case is different. There is practically no limit, except the limit of cost, to the thickness and weight of earthworks, harbor defenses, bomb proofs, the weight of machinery, or the space in which the guns are disposed. The guns themselves may become obsolete to a degree; but even then the case is not serious, as with the battleship; for increased protection will do much to restore at least part of the value of the gun. And when the gun finally becomes obsolete, it may be removed and, for comparatively small expense, replaced by another of adequate power. In other words, the fort does not become obsolete as a whole; certain parts may, but they can be readily replaced at comparatively small cost. Let but a few elements of the armament of a ship become obsolete, and the ship herself becomes obsolete, because the design of the ship is such—one part depending intimately on many others—that to replace but a few elements would involve the replacing of the whole.

It must not be taken, from any of the foregoing, that the navy will not have its function to perform in connection with the Canal; nor that that function may not at times partake of assisting in the defense of the Canal and co-operating with the shore fortifications. This is apart from the main question, however, and is merely referred to in order that it may not be thought that this phase of the question has been overlooked.

Now, some amiable believer in international neutralization or some equally amiable advocate of a canal defended by a navy alone may say, after all this: Why should not all of our defenses be taken over by the army and the navy abandoned as a means of defense? The answer seems almost too obvious. But the proper answer to the whole question seems obvious; and yet the question has been put from all sides.

The answer to this last question might be something like this: The warship is a highly expensive agent of offense and defense when compared with a shore fortification. It is necessary, however, in the various operations of naval warfare and the various operations of combined military and naval warfare. While the fort is a comparatively economical agent of offense and defense when it can be placed with certainty at a point where, on account of strategic considerations, military, naval, or commercial, attack may reasonably be expected, it is out of the question to so multiply fortifications as to defend the whole coast line against military attack. The two agencies are just as necessary to the complete protection of our maritime frontiers as the combination of infantry and cavalry with frontier forts is necessary to a proper protection of the non-maritime boundaries ot a country.

—*Thr Navy*, January, 1911,

◆ ◆ ◆

EFFECTS ON COAST DEFENSE OF NAVAL DEVELOPMENTS OF THE LAST FEW YEARS

By Bellfield

It is difficult to discuss this subject from any point of view without plagiarizing to a very large extent on the exhaustive article by Colonel W. R. W. James in the May number of the *R. A. Journal* entitled, "Problems Involved in the Defense of Coast Fortresses," and such being the case, we hope no further apology will be needed if many of our present conclusions appear to be based on his arguments. In the article in question convincing proofs are adduced showing the absolute necessity of coast defenses—not coast defenses of mobile batteries as favored by some writers who have perhaps a cursory knowledge of the subject—but coast defenses consisting of carefully sited fixed armaments, electric lights, and range-finding instruments, all linked together by a reliable system of communications. These proofs lead us to the general conclusion that the all round increase of naval power makes it of vital importance that our coast defenses must be strengthened in a corresponding ratio.

Considering recent naval developments in detail, the most important changes that affect coast defense, of late years, seem to be:—

1. Increase of gun fire power.
2. Development of the submarine.
3. Increase in size and power of torpedo-boats.
4. Increased use of blockaders and boom-smashers.

Of these headings, the first is much the most serious consideration owing to the large number of heavy guns mounted by the modern battleship and cruiser of all the great naval powers. This may be well exemplified by comparing the total weight of a broadside from the *St. Vincent*, which was laid down in December, 1907, with that of one from the *Lord Nelson*, which was launched as recently as 1908, that is just before the "Dreadnought" era and while the *St. Vincent* was still building. In the former case the weight of a broadside is roughly 7200 pounds (all these figures are given in round numbers) and in the latter it is only some 5400 pounds. Going back a few years further we find that the *Ocean*, completed in 1900, can only show a broadside of 4000 pounds compared with something like 13,000 pounds of the unfinished *Orion*.

From these figures it is obvious that the gun power of ships is increasing at a tremendous rate, in fact one wonders when the limit will be reached, and how long the different nations will continue "to go one better" than their rivals. Now turn from the ships to the shore and see if the primary armaments of our coast defenses are being correspondingly strengthened.

It is said that figures can be made to prove anything, but, at the risk of being considered too statistical, we will venture to give some hard facts about the "progress" of our fixed armaments from 1905 up to the present date, that is to say during much the same years in which we have glanced at the naval increase in the same direction. To do so we will take two examples of what has happened in the case of two typical coast fortresses, one at home and one abroad; the names of the particular places do not matter, but suffice it to say that they are both places of by no means secondary importance.

At the home station in question in 1905 there were 41 guns of all descriptions available for the defense of the dockyards in rear, giving a total "broadside" of about 8300 pounds, not, of course, that the whole of the armamen could actually fire at the same target at once. In 1909 there were 19 guns, with a broadside of 2700 pounds, defending the same port. The remainder (two new guns had been added) were either dismantled or in reserve, which is for all practical purposes the same thing, seeing that there is neither personnel available to man them nor stores at the station for use with them. It is freely admitted that many of the original 41 guns were of obsolete pattern, but with the exception of the two guns mentioned, nothing has been done to replace them.

Turning to the colonial station we find the following facts; five years ago there were 16 guns guarding the entrance to the harbor, with a total broadside of 1660 pounds, now there are four guns left on the active list with a broadside of 960 pounds.

Judging from these instances, the recent naval development of gun fire power has been accompanied, not, as one might expect, by a similar increase in the power of coast defenses, but by a very material reduction; and this in spite of the fact that the "reduction of armaments" theory is supposed to be quite exploded. Let us try to follow the reasoning that has led to this apparently unreasonable line of action.

Some twenty years ago the opinion seemed to prevail that the fixed armament of a defended port might have to reckon on the possibility of being engaged in a regular pitched battle with several hostile battleships or cruisers. As a matter of fact such was exactly the case of the Spanish coast batteries at Santiago in the Spanish-American war, as recently as 1898, when the American fleet steamed past the forts at a range of under 3000 yards and poured a tremendous fire into them. (As it happened there was practically no damage done to either personnel or material in the forts as the detachments went under cover and there were no direct hits on any of the guns.) By this time, however, any chance that the Spanish may have ever had of holding the command of the sea was almost certainly lost as their fleet lay huddled in the narrow Santiago harbor unable to venture out to try conclusions with the stronger American fleet which was blockading it. Still there is this to be noticed, that the American ships could not risk entering the harbor under the point blank fire of the guns mounted at the entrance.

Now the modern theory is that we take it for granted that we have command of the sea, and the only danger to be feared by any of our fortified ports (not taking into account torpedo-boat raids, which we will come to later) is from an odd cruiser or two that may have evaded the notice of our fleets. Another idea is that the modern type of battleship, costing something like £2,000,000, is too precious an article to be allowed to run any risks of being damaged by fire from a fort when its real rôle lies in the attack of the hostile ships in line of battle. Here we would like to quote two sentences from Colonel James' article: "There is nothing inherently improbable in ships engaging a fortress, either with the idea of silencing the batteries, or more probably in order to disorganize the light Q. F. defenses and thus prepare the way for a torpedo-boat attack." Again: "Ships, at any rate at the present moment, are not so very vulnerable, especially considering the 9.2-inch is our largest modern gun mounted in fixed defense."

This last sentence seems to contain the crux of the whole situation, namely, that we ought to have something in the nature of a 12-inch gun for our primary armament of coast defense. It is quite conceivable that at a defended port in some part of the world (possibly even in home waters) we might happen to have lost the command of the sea for the time being and our ships might have been roughly handled and have gone into port to refit. Now we may take it for granted that the hostile fleet would follow up its success and try to bombard our ships in the harbor unless we have fixed defenses able to make the enemy keep at a respectful distance. In other words, we would require as powerful a gun as that carried by the ships which we would have to engage. Turning to recent history we have excellent examples of the inefficacy of insufficiently powerful coast defense armament. On the 9th February, 1904, the Japanese fleet bombarded Port Arthur with their heavy guns and, according to the Official History of the war, the range was so great that very few of the Russian guns were capable of making an effective reply to the heavier Japanese weapons, and "confusion reigned throughout the fortress." In a later bombardment, in March, about 150 12-inch shells were dropped into the town and harbor, and again "the coast batteries were incapable of inflicting injury on the Japanese vessels." During the blockade of Santiago by the American fleet the Spanish forts had no fixed armament heavier than a 6.3-inch B. L. of very old pattern, with the result that the American ships were able to steam past at a range of under 3000 yards, but if there had been good primary armament on shore, this could never have been attempted and the Spanish warships in the harbor might have had some chance of slipping out on a dark night.

Again, modern armored cruisers have better protection than formerly, just as they have also increased gun power, and they are the most likely type of ship that our coast defenses will have to fire at while we still have command of the sea. They are the ships which would be engaged in the work of escorting blockaders and boomsmashers and it is obvious that it would be of the first importance to put such escorts out of action at the farthest possible range, so that the secondary armament could deal with the unprotected blockaders without the probability of its being overwhelmed by the fire from the cruiser, for it must be remembered that the gun power of one fair-sized cruiser is superior to that of most of our fixed defenses at any one port which could bear on the same target at once.

SUBMARINES

Now coming to the question of submarines, their present rôle is mainly as an adjunct to the defense of a port, but doubtless they will soon develop into assisting the attack, so our coast defense ought to have some means of coping with them. Some of our most important dockyards are not so far from foreign naval bases that they can be considered immune from possible attack by this invisible enemy, but it is difficult to see how the guns of the fixed armament can deal with such an attack unless the submarines rise to the surface unexpectedly. Even at short ranges it would be too much to ask the most skillful Q. F. layer to take a periscope as his target.

Submarines will have to be met by submarine, but one cannot help regretting the abolition of regular minefields and the Brennan torpedo installation, which in narrow waters was a very certain instrument of destruction. After the important part played in the naval operations of the Russo-Japanese war, it seems to be assured that mining will enter largely into any future naval war, and, as a means of coast defense, the moral effect of knowing that a port is protected by a minefield is by no means the least powerful deterrent to a possible attack. Both the Russians and Japanese lost large ships from mine explosions although there was no system in sowing the mines, and if it had not been for them, Port Arthur would no doubt have suffered much more severely from the fire of the Japanese fleet, which very soon gave up coming too close to the port as entailing too much risk.

The effect of the introduction of the submarine has, therefore, been to abolish mining, at any rate systematic observation of mines, as one of the agents of coast defense and to give us the submarine in exchange. Whether the latter will be as effective as a minefield in difficult channels is a question upon which opinion is still divided, and will be divided until the submarine has been tried practically in actual war. Unfortunately in neither of the two modern naval wars did any of the contestants make use of submarines, so their future use is to a large extent problematical.

One suggestion that might be advanced to assist in keeping hostile submarines out of a harbor is whether it would not be possible to hang something in the nature of torpedo netting from the boom at the entrance to the harbor. In places where there is a strong tide the idea would very likely not be feasible, but at some ports it might prove useful and the present delicate type of submarine would scarcely care to try and charge through a heavy netting.

TORPEDO-BOATS

As regards the development of the torpedo-boat and destroyer there is not the slightest doubt that our anti-torpedo-boat coast defenses require re-arming at once. It has been unquestionably proved that a 12-pounder is too light a gun to put the modern large and swift destroyer out of action with the rapidity necessary. It is again the question of a considerable increase on the part of the ship accompanied by no corresponding increase on the part of the fort, though just as the 6-pounder was superseded by the 12-pounder, so ought the 12-pounder to retire before the superior claims of the 4-inch Q.F. We have heard many rumors during the last five years or so about the proposed rearmament of the light Q. F. batteries, but except for some batteries in the Mediterranean, the rumors do not appear to be materialising very rapidly. Nevertheless it seems to be fairly well understood that the conventional method of declaring war in future will be to make a torpedo-boat raid on some important harbor of the enemy, and the chance of damaging one of our few "Dreadnought" docks would be a very tempting lure to a hostile flotilla. Coming, as they certainly would, in large numbers, we need a gun the shell of which can do sufficient damage to put a torpedo-boat out of action by one hit, so that the gun can be immediately switched on to the next target.

Though more a political than a naval development, this subject of the more or less unexpected raid affects coast defense very greatly as our present "precautionary period" would quite possibly turn out to be "a snare and a delusion." Great Britain is unlikely to be the aggressor in such a raid, partly because of the strong influence of the "peace at any price" party in the country, and partly because of the feeling that it is unsporting to start, as it were, before the whistle blows, so the attack would probably fall on our coast defenses while they were waiting in the embryo precautionary stage. It is no doubt a very effective piece of work at annual manœuvres—passing from one stage to another on receipt of a telegram from the General Staff—but when there is any idea of real war it would be advisable to go to the war stage at once, or the magic telegram may be found to arrive too late at the port to which the enemy turns his premature attention.

BLOCKADERS

The use of blockade ships and boom-smashers can scarcely claim to be a very modern development in naval warfare, but in both the recent naval wars from which we have already taken examples, there were strenuous attempts made to blockade the enemy's fleet in a harbor where it had retired for refuge. The Japanese made several attempts to block the entrance to Port Arthur with ballast laden vessels, with the result that Admiral Togo was able to report that "the entrance appears to be completely blocked to the passage of cruisers and larger vessels." At Santiago the Americans tried to close the harbor by sinking the collier *Merrimac* at the entrance, but though it was sunk in the position intended, the channel was still wide enough for the Spanish ships to get past the obstacle in their attempt to escape.

Our present secondary armament of 6-inch guns is not heavy enough to sink a well ballasted blockader at the distant range necessary (proof of this is given in Col. James' article in the case in which 6-inch shell, fired at point blank range, were unable to sink a coal hulk), so for this purpose we would need to use the 9.2-inch guns, which, according to our present armament, would be wanted to engage the escorting cruisers.

The conclusion of the whole matter based on the foregoing arguments is that our present coast defenses require an all-round increase in power to keep pace with the rapid advance of naval developments; we want 12 inch guns to take the place of the 9.2-inch, we want the 9.2-inch to take the place place of the 6-inch, and 4-inch to take the place of the 12-pounder. The Blue-Water theory may be perfectly sound, but it is imperative to have really strong coast fortresses in case of the theory being temporarily upset.

—*The Journal of the Royal Artillery*, January, 1911.

EFFECTS ON COAST DEFENSE OF THE NAVAL DEVELOPMENT OF THE LAST FEW YEARS

By Captain T. W. Saidler, (Forth) R. G. A.

The coming of the *Dreadnought* the "all big gun" battleship in 1907, is held to have initiated an entirely new era of naval development, and we may thus properly consider what effect this has had, and will have, on the Coast Defenses of the British Empire.

At the first glance the inauguration of a type of war ship carrying ten or twelve 12-inch guns in the place of a ship carrying only four of these weapons appears an overwhelming advance in the powers of attack, and against other warships, or against the old iron shielded masonry, and iron plated forts of the 1860-70 period this is doubtless so.

But these forts were already outclassed by the gun. Designed to resist attack from the 12-inch R.M.L. firing every two minutes or so, a projectile weighing 614 pounds, with a muzzle velocity of 1,300 feet per second, a muzzle energy of 7,195 foot tons, and a penetration into wrought iron of 15 inches, they were hopelessly overmatched by a 12-inch B.L. gun such as was carried by the older battleships, firing an 850 pound projectile *four* times in two minutes or oftener, with a muzzle velocity of 2,450 feet per second, a muzzle energy of 33,940 foot tons, and a penetration into wrought iron of 34 inches.

Newer and more powerful guns of 12-inch caliber have since been introduced and a 13.5-inch gun with some 60,000 foot tons energy is now being introduced into our own Naval service for the *Lion* and probably the *Orion;*

and other countries are following suit, the United States with a 14-inch gun, and Germany with one of a similar caliber.

The effect of heavy gun fire on such structures was demonstrated only too clearly in the Shoeburyness experiments in 1883. The 80 ton R.M.L. gun firing a palliser chilled shot of 1700 pound weight, with a muzzle velocity of 1,588 feet, penetrated two 8-inch iron plates, and ten feet into the granite behind, cracking it for some distance all round the point of impact.

Where it was impossible (as was generally the case) to strengthen these old forts by the addition of extra plating, they have for long been relegated to a second place, if not actually abandoned as a part of our Coast Defenses, and against the fire of a *Dreadnought* or *Invincible* not to speak of a *Lion* or *Orion*, they would simply prove death traps for their unhappy detachments.

In the case of modern earthworks of the type now scattered round our coasts however, the effect of the new development is not so striking. In a modern work the guns are, as far as possible, mounted at a height above sea level, are widely dispersed, the emplacements sunk below the natural level of the ground, only the gun itself, with a stout steel shield to protect the carriage and loading and laying numbers, appearing above the surface.

In the 9.2-inch, the principal weapon of our Coast Defense, the target offered to an approaching enemy is thus only about 15 feet by 6 feet, a very small target indeed at a range of 6,000 or 8,000 yards. But small as this target is, it is all that a hostile warship has to fire at. A shot falling short only throws up a shower of earth and stones, or richochets harmlessly over head; one going too high does no injury whatever to the battery, but buries itself in the distant hillside, or splashes aimlessly into the sea. Nothing but a direct hit on the gun or shield will do any harm to the battery or put a gun out of action.

But to put a 6-inch or a 9.2-inch gun out of action does not require a hit from such a ponderous weapon as a 12-inch gun, the shell from a 6-inch gun is all that is required—it is number, more than weight, of projectiles that would tell in the attack of a coast battery. Now one of the older battleships mounting four 12-inch and twelve 6-inch guns, could fire on the broadside all her 12-inch and six of her 6-inch. Each of the 12-inch could discharge in a minute two rounds, or in all 8 rounds. Each of the 6-inch, at a very moderate estimate, 6 rounds a minute, or in all 36 rounds, or 44 projectiles a minute. Against this the *Neptune* could fire two rounds a minute from each of her ten 12-inch guns—all of which can bear on the broadside, although not on other trainings—that is 20 rounds a minute. Of course the *Neptune* would add to this the fire of a number of 4-inch Q.F. guns, but these are probably too small to do much harm. The *Dreadnought* herself and some of her earlier sisters can only bring eight guns to bear on the broadside, and they have no secondary armament larger than a 12-pounder.

To add to the difficulties of the attacking ship most coast batteries are now as carefully concealed as possible, the sky line avoided, and guns painted to harmonize with the adjoining ground, so that it is very hard for the gunners on the ship to get anything very definite to lay on.

The position finding station may be hundreds of yards away from the guns and absolutely invisible from the sea, and is probably in duplicate, so that even if one were wrecked by a chance shell, the service of the gun by the other would go on practically as if nothing had happened.

Therefore, as before said, nothing but a direct hit on the gun itself or shield, does the slightest harm to the battery.

On the other hand the ship is exposed from stem to stern. A vessel 500 feet long by 30 feet freeboard, broadside on, offers a target of 15,000 square feet, against the 90 square feet of the gun on shore Nine to eleven inches of hardest steel may protect its vitals, but still large parts of its sides bear only two to three inch plates, while still larger parts are entirely unarmored. Most of its Q.F. guns, being designed only for defense against torpedo boats, are perched on the top of barbettes or otherwise exposed to the smallest projectiles.

The rangefinding apparatus occupies a very precarious position on the top of a mast. The blast of a lucky H.E. shell, striking near the eyeslits of the conning tower may kill or disable the Captain and all his assistants. Such a shell bursting anywhere except on the thickest armor, will work serious damage, cutting the muzzles off guns, bringing down masts, crushing in thinner armor at the bow or stern, letting in the sea, and making the ship unmanageable.

Then the land gun is on an absolutely steady platform, while the ship may be rolling with the sea, rendering shooting difficult. The rangefinders on shore have instruments accurate up to 12,000 yards and a fixed base. The rangefinders on the ship have an obscure and difficult target, and, like the gunners, have an unsteady platform, and an instrument accurate only up to medium ranges. The observers on shore can see the splash of every shot, and correct their range accordingly, while those afloat may lose sight of most of their projectiles going over or falling short, and burying themselves in the earth. Thus then all the advantages should be with the shore batteries in a duel.

Still, as long as the thick armor is unpenetrated, the ship can steam and work and fight her heavy armament, and once past the batteries, might still work terrible havoc beyond. This is where most of our modern works are at a disadvantage. The old 80 ton and 100 ton M.L. and 67 ton B.L. guns, which were a match for any armor afloat in their days, are now things of the past. Few if any guns heavier than a 9.2-inch, are now mounted in our land works. This gun, powerful though it is, is no match for even 9-inch Krupp armor except at the very shortest ranges, as ranges go now, and most foreign ships now carry two or three inches more than that. The United States ship *Wyoming*, has 11-12 inches, Italian *Michael Angelo* 12, the French *Danton* 10, the German *Nassau* 11, and others building are to have even heavier protection.

To deal with these vessels, to make the risk of disablement in running past a fort too great to be lightly incurred, we must have heavier guns, guns of the most powerful nature possible, the new 13.5-inch for preference. Heavier guns than the 9.2 cannot be worked successfully by hand, so these new guns must be worked by power, hydraulic or electric. The old 80 or 100 ton R.M.L., the 67 ton B.L. also, had all power installations, hydraulic or steam, and there is no reason why this should not be applied again.

The 12-inch gun on shipboard, with its two rounds or so a minute, is now really a quick firing gun, and practically the same rate of fire is expected from the new 13.5-inch. . What can be done afloat on an unstable platform like a ship, should be much more readily done ashore, and there can be no difficulty, but the expense, in mounting a few 13.5-inch guns at our main ports, with hydraulic or other power for working them. The men that can take care of the complicated Mark V mounting of the 9.2-inch are perfectly competent to look after any other machinery that may be committed to their charge.

Such guns would be able to perforate any armor afloat for a long time to come, would effectually deal with any hostile vessel attempting to run past them, or by coming close in, trusting to her thick armor, to destroy shipping or buildings beyond, and leaving to the 9.2 the attack of the thin armor, or unarmored portions.

In regard to defense against torpedo craft, the arguments used against the 9.2 may be used with equal force against the 12-pounder Q.F. gun, still the chief weapon against torpedo boat raids.

Although the speed of these craft has not risen much (if indeed it has not, on the average, decreased, with the introduction of the river class and similar boats) within the last few years, their size and seaworthiness have made vast strides, and consequently their radius of action, putting many places, formerly considered entirely outside the zone of torpedo attack, in positions of great danger in the event of hostilities with any naval power.

From vessels of 200 tons we have risen rapidly to 500, 600 or 900 tons, and in the case of the *Swift* to a boat of 1,800 tons with engines of 30,000 h.-p. Although still of very slender scantling, these boats have their boilers and machinery well protected by coal bunkers, and a 12-pounder is extremely unlikely to effect a vital injury. Already this has been recognized by the Naval Constructors, and the 4-inch or 4.7-inch or heavier guns are now mounted on all the latest battleships for defense against torpedo attack. The same course must be adopted ashore, the 12-pounder must follow the 1-inch Nordenfeldt, the 3-pounder and 6-pounder, and be replaced by a gun certainly not lighter than the 4-inch.

The introduction of the submarine boat in place of mines is the latest and most difficult problem in coast defense. The value of these craft has never been tested in modern warfare. How they are going to maneuver and fight against rapidly moving vessels in the narrow and often comparatively shallow waters of our estuaries and harbors, with strong tides and currents, is a question that their commanders alone can answer.

The terrible efficiency of the submarine mine we know, as it showed itself in the Russo-Japanese war, and somewhat less recklessly applied, it was a cheap and effective method of defending a port. The moral effect of the mere presence of mines was sufficient to make hostile vessels approach cautiously and deliberatly, and thus give the guns a better opportunity for attack. Whether the submarine boat will prove an efficient substitute, real war alone will show. Of course the moral effect is as great, if not greater, and will prevent warships anchoring or stopping anywhere that boats are suspected to be, which will tell against the effect of their fire, while the submarine boat does not need to await the enemy's approach, but can go out to meet him. This is an addition to the powers of the defense, and will render the blockade of a port an even more hazardous and nerve-racking duty than it ever was before.

As to air-ships we can hardly say that we have much to fear from them as yet. True, they have certainly done some wonderful things, but only in the calmest and most favorable of weather, and often after days and weeks of waiting for an opportunity. The recent aviation meetings have shown again and again, that in a breeze of anything more than 10 or 15 miles an hour they became, when they dared to venture out, helpless and unmanageable. How many days a year are our British coasts free from winds of this or greater force? Besides, they are extremely delicate and liable to accident, as the ever increasing death roll in the papers only too clearly shows, and at present there seems to be little prospect of their becoming less so within the limits of weight permissible. Should they ever become more effective, guns on the lines of Krupp's anti-airship gun, will soon be introduced to deal with them, and an overhead cover of strong wire netting would greatly lessen damage to guns or detachments from any bombs likely to be dropped from above.

On the whole, then, we may say that the main lesson to be learned from the recent naval developments is the urgent necessity for heavier guns in our coast batteries. Otherwise the balance of gain and loss is not unfavorable to the defense.—*The Journal of the Royal Artillery*, January, 1911.

EFFECTS ON COAST DEFENSE OF THE NAVAL DEVELOPMENTS OF THE LAST FEW YEARS

A reply to "Rehabilitate"

By MAJOR N. E. B. BELLAIRS, R. G. A.

"Rehabilitate" has in the October number of *The Journal of the Royal Artillery*, written an article under the above title, which provides ample food for thought; but I cannot allow his conclusions to pass without demur, and have selected the two following paragraphs from his article, as open to further discussion.

Para. 1.

"Except for some minor details and for the more complete training of the personnel, Coast Defense has been stationary for some years past; and the naval developments, which amount almost to a revolution in the attack, have all taken place since the successive introduction of the D. R. F., the P. F., the anti-T. B. armament and the B. L. 9.2-inch on the Mk. V. carriage placed the defense in its present position of excellence.

Para 2.

"To sum up the moral to be drawn is that the defense must more than ever keep in touch with naval developments and naval methods both at home and abroad; that home and foreign naval estimates and dispositions in the near future will affect the plans of the defense more than any other factors; and that, for the present at least, the Coast Defenses are in a position to do all that may be expected of them, though perhaps not all that they might wish to be able to do so."

In para. 1 we are told, that the developments in Coast Defense for some years past are in minor details, while those in the navy are described as almost revolutionary. It would not be amiss to enumerate a few of the minor details. Readers can doubtless add largely to their number, and judge for themselves whether they are rightly classed as "minor."

They certainly are not revolutionary, but when we consider that the naval developments, as far as fire control are concerned, are likely to be nullified by the failure of the electrical communications, which are very open to attack, they certainly weigh in the balance.

These details include:—

1. Increased knowledge of the behavior of our guns as regards wear,

etc., owing to which, we, on shore, expect to obtain the range of our targets to within fifty yards, with our opening rounds, if we do not actually hit them.

2. *Provision of dials on mountings and elevation indicators.* The result of this is an increased rate of fire and better cover for gun layers. The rate of fire with 6-inch B. L. Mk. VII owing to this provision, has, in my opinion, been increased quite 30 per cent.

3. *Bearer loading for 9.2-inch B. L.*, giving an increased rate of fire over derrick loading almost equal to that of hydraulic loading.

4. *Provision of loading trays for Light Q. F.*, which has caused an increased rate of fire with the 12-pounder of some five rounds a minute.

5. *Replacement of 12-pounder Q. F. by 4-inch Q. F.* in certain situations, owing to the greater resisting powers of modern destroyers, and the more certain detonation of the modern, light high explosive shell, rendering the remaining 12-pounder Q. F. more effective.

6. *Provision of dial sights*, and the greater attention paid to training with movable armament and armament for land fronts.

The second paragraph I have selected from "Rehabilitates" article lends itself to very adverse criticism. "Dispositions" can be altered in a day, not so "Coast Defenses."

Some of our "Coast Defenses" are at the present moment left dangerously isolated, owing to the concentration of the majority of our ships in home waters at the recent re-distribution. Those ships left would be unable to cope with superior fleets, and would either have to concentrate or temporarily seek the shelter of the Coast Fortress guns and constitute a "Fleet in Being." The reduction of that Fortress might for this or some other reason, become a primary strategical object, which would have to be carried out.

That ships are no match for forts under modern conditions is a dangerous assumption, and at least one writer on naval subjects—Fred T. Jane—has issued many a note of warning. Perhaps it is not too much to say that a Fortress, as at present constituted, may shoot all day at a modern battleship without putting a single gun out of action, or letting in a drop of water, if firing at a range of 12,000 yards.

We must not hide from ourselves unpleasant facts, and I enumerate a few as regards our 9.2-inch B. L. guns—the heaviest mounted in coast defense.

1. That uncapped projectiles only are provided, which will probably glance, unless striking armor plates at an angle of more than 40°; while capped projectiles would bite at a lesser angle. I am aware that Garrison Artillery Training lays down a striking velocity which, if not attained, renders capped projectiles of no advantage, but I do not think the question of glancing has been considered in arriving at this dictum.

2. That this angle is never likely to be greater than 60°. To compensate for this, one third of the thickness of armor should be added in considering whether the armor is within the power of the gun.

3. That Krupp cemented armor is now almost universally used in warships, and that the 9.2-inch armor piercing projectiles, if uncapped, are overmatched by a 6-inch Krupp cemented plate, at a range of 5,000 yards, under these circumstances. Whereas with a 12-inch gun a plate of 9 inches is well within its power.

4. With a capped projectile at 5,000 yards, the said 6-inch plate would just about be matched.

Points 3 and 4 need only be considered if ships must necessarily run past these guns, as in the case of narrow estuaries, and if the said ships cannot put these guns out of action at the longer range of 12,000 yards, which it is anticipated, that if possible, they will adopt.

5. That the heavy armament of the latest foreign warships could fire and do damage during bombardment, at ranges practically impossible to ourselves, and would do so if they could afford to expend the ammunition, without risk of falling short, in view of a possible fleet action.

Other facts will present themselves to readers, but I think enough has been said to constitute an urgent plea for the replacement of some of our 9.2-inch guns by others of 12-inch caliber, and the substitution of capped, for uncapped A. P. projectiles, universally. Also that our land mountings for heavy guns should be modified as to allow of twice the quadrant elevation they at present provide.

What is asked for in this plea, is the minimum that should be provided, if guns mounted on shore are to deter even the modern cruiser of an enemy—from bombarding. My point is that our present armament will exercise no deterring influence on an enemy's navy—if modern—which is the "prima facie" reason for its existence.

—*The Journal of the Royal Artillery*, January, 1911.

◆ ◆ ◆

THE LAURENTI SUBMERSIBLE

(Abstract)

Major Laurenti, formerly of the Italian Navy, is now at the head of the Fiat-San Giorgio of Spezia, builders of submarine boats of the design invented by Major Laurenti. The principle is laid down that surface speed is more important than submerged speed—that the vessel must be capable of covering quickly wide zones of inactivity to bring her to the scene of action, where less speed will suffice. The Swedish Laurenti submersible, *Hvalen*, 1909, is considered a good example. Her characteristics are:

"Length overall, 140 feet; beam, maximum, 14 feet; displacement, light, 186 tons; displacement, fully submerged, 230 tons; number of screws, surface propulsion, 3; number of screws, submerged propulsion, 2; maximum brake horse-power (shop), 1,050; maximum surface speed, 15 knots; radius of action, surface, full speed, 480 knots; radius of action, at 9 knots, surface, 1,200 knots; maximum submerged speed, 7 knots; radius of action, submerged, full speed, 21 knots; number of torpedo tubes, 2."

The hull differs in shape from that of other submarines, following closely the lines of a surface torpedo boat.

"Fig. 1 (page 228) is a diagrammatic sketch of the essential characteristics of a section of a Laurenti submersible. A B C D is the contour of the main or pressure-resisting hull. M N the plating of the superstructure which is water-tight when the valves V V are closed, but which is self-filling in submerging, or self-exhausting when emerging if these valves be open. W W are ballast tanks. K K are Kingston valves. D is the vertical keel and the longitudinal water-tight subdivision of the ballast tanks. X X is the normal surface load waterline and X^2 X^2 is the waterline with the superstructure *closed* and all the ballast tanks except the final submergence tank filled."

Fig. 3 (Fig. 2 is not reproduced) shows the three stages of a Laurenti boat, from light surface condition to readiness to dive. The superstructure automatically fills, as the boat sinks, and empties as she rises again.

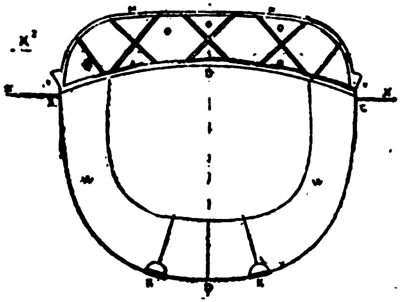


FIG. 1. SECTION OF LAURENTI SUBMERSIBLE

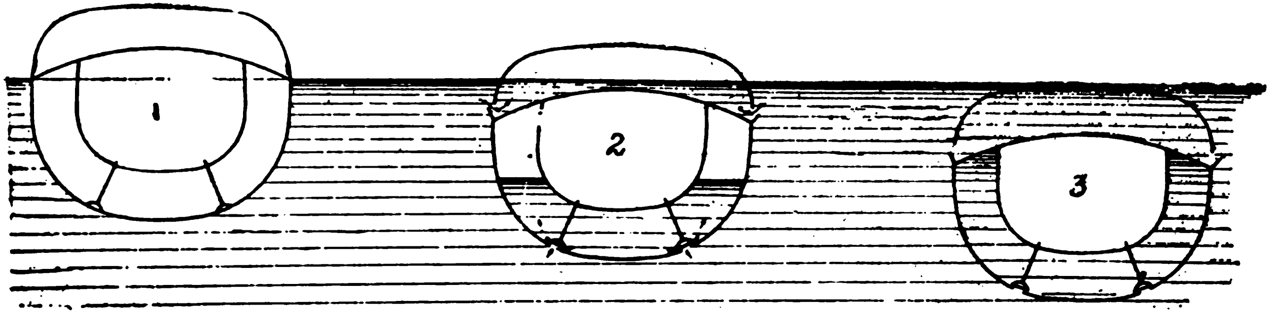
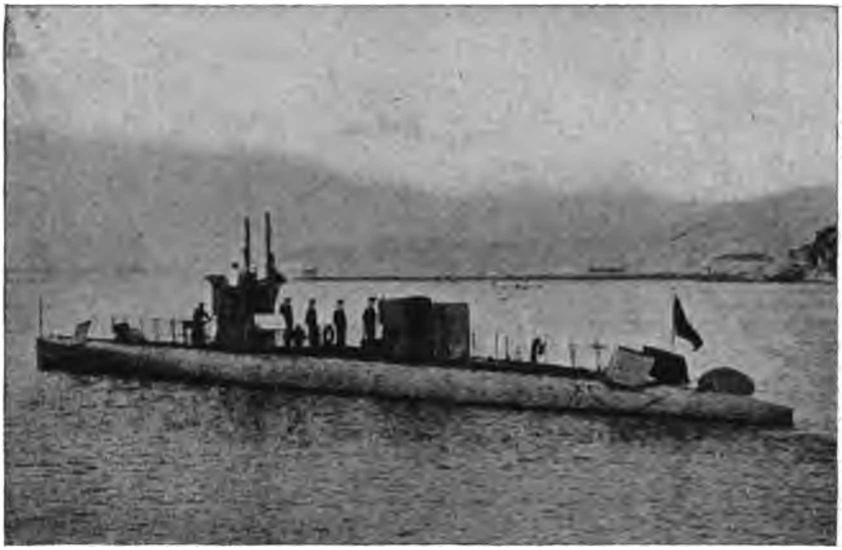


FIG. 3. THE THREE STAGES OF A LAURENTI BOAT, RANGING FROM THE LIGHT SURFACE CONDITION TO THAT OF READINESS TO DIVE



Page's Weekly

SWEDISH SUBMERSIBLE "HVALEN," BUILT BY THE FIAT-SAN GIORGIO, SPEZIA

When this boat is running on the surface the submerging rudders, fore and aft, are turned up out of the way as shown in the photograph

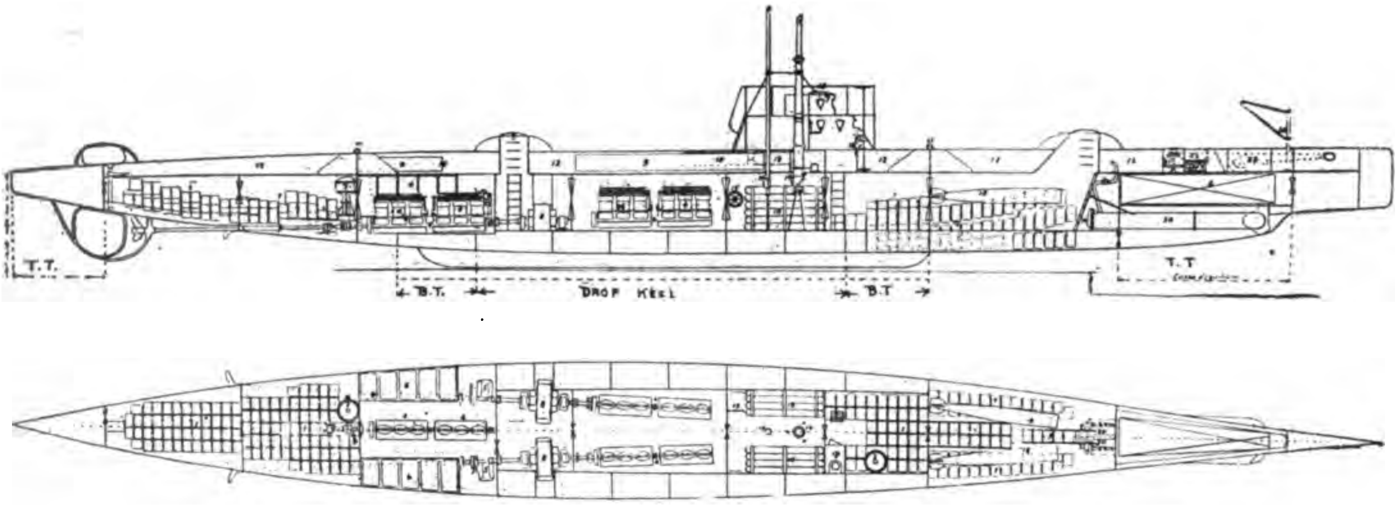


FIG. 4. GENERAL SKETCH OF A LAURENTI SUBMERSIBLE

A typical inboard profile and internal plan view of one of the latest Fiat-San Giorgio's boats. The first thing that strikes one at all familiar with under-water boats is the manner in which the Italian submersible is subdivided into eight water-tight compartments

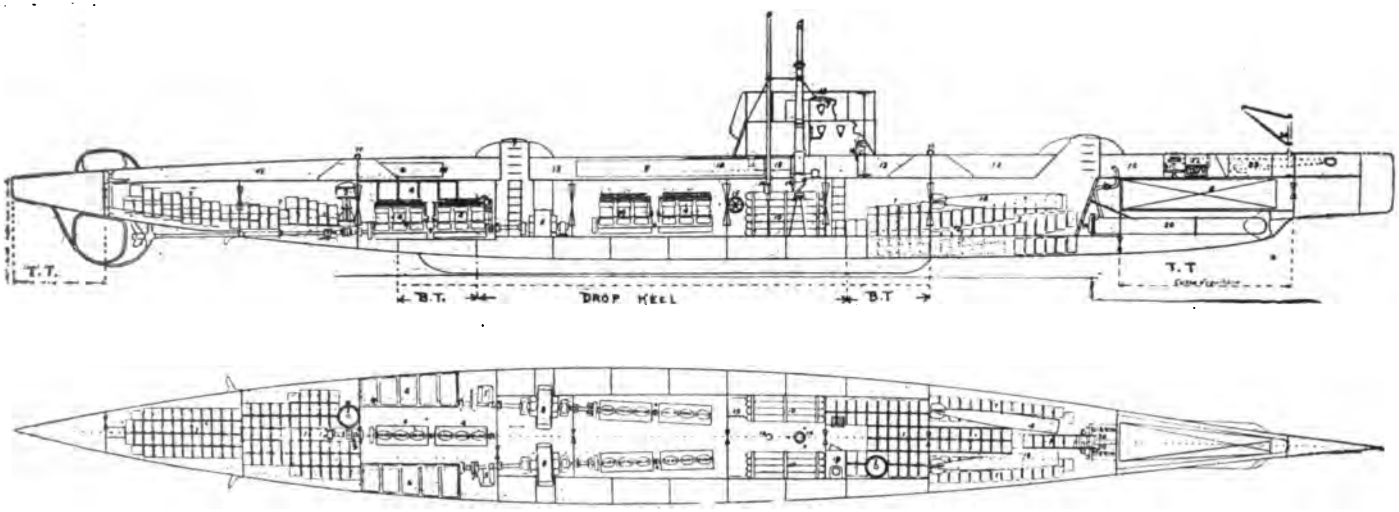


FIG. 4. GENERAL SKETCH OF A LAURENTI SUBMERSIBLE

A typical inboard profile and internal plan view of one of the latest Fiat-San Giorgio's boats. The first thing that strikes one at all familiar with under-water boats is the manner in which the Italian submersible is subdivided into eight water-tight compartments and they on him—until he knows what constitutes the essentials in the art of artificial respiration. By this method even a child can operate on an adult and maintain sufficient inflow and outflow of air (tidal air) to supply him with as much air as he would secure were he able to breathe voluntarily.

The prone position of the patient allows the tongue to fall forward, and permits water and mucus to escape from the mouth; for this reason the prone pressure method is the ideal method of resuscitating the drowning, for there is no loss of time in first pressing out the water, as by the old method. Edema of the lungs (accumulation of blood stained serum in the air vesicles and bronchioles) sometimes complicates the profound collapse of electrical shock; hence this method, as it allows the blood-stained mucus to flow out, is to be preferred. Furthermore, as an operator can work without exhaustion for an unlimited length of time by this method, there is no need of team work and working in relays, as, for example, with the Sylvester-Laborde method.

If the operator is alone, the artificial respiration is his chief concern and offers the only hope for the victim; yet, if there are others to assist, there are measures supplemental to the artificial respiration that may be carried out.

1. Aromatic Spirits of Ammonia, on gauze or cotton held near the nose, stimulates the respiratory function—is even more useful than oxygen—yet is valuable only as an adjunct to the other measures.
2. A dash of cold water in the face.
3. Spanking the buttocks.

Should the respiratory function continue in abeyance, the physician, upon his arrival, may render great assistance by the hypodermic administration of Atropine Sulphate gr. $\frac{1}{100}$ and Strychnine Sulphate gr. $\frac{1}{80}$, which can be repeated at his discretion, or he can stretch the sphincter ani.

No liquid should be given by the mouth to a patient in shock, or with suspended activity of the reflex nerve centers from any cause; if given under these conditions it is more liable to enter the lungs than the stomach.

Electrical accidents, as encountered in the industrial applications of electricity, may be classified as: First, flash injuries, embracing burns of the eyes and the skin, and second, contact injuries, embracing suspended animation and burns often of a severe character. The even brief consideration of these several types of injuries is not within the scope of the present article, and, as they require the attention of the surgeon, it is understood that the patient for whom artificial respiration has been done, if he be simultaneously burned by the contact, will subsequently need the surgeon's care, as the healing of such electrical burns is in some cases quite tedious.

In the language of E. A. Schafer, Professor of Physiology in the University of Edinburgh, the prone pressure method of artificial respiration "proves to be completely efficacious and capable of effecting an air exchange greater than that produced in normal respiration." This conclusion was reached after all other known methods had been experimented with and found inferior, in the investigations carried out under the auspices of the Royal Medical and Chirurgical Society of London of whose committee Professor Schafer was chairman.

The prone pressure method has received quite universal recognition and in England has been officially adopted by the Royal Humane Society, the Royal Life Saving Society, and the Coastguard Service. One can acquaint himself with the method in ten minutes, and such serious consequences result from delay in case of suspended respiration that ignorance is inexcusable, especially among electrical men. The practice of the Westinghouse Electric & Manufacturing Company in holding weekly classes of instruction in the art of artificial respiration in order that all employees may familiarize themselves with the method may well be followed.

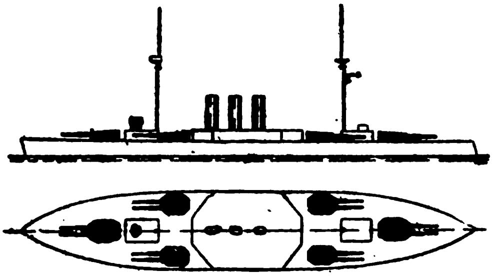
—*The Electrical Journal*, February, 1911.

◆ ◆ ◆

LAUNCH OF JAPANESE BATTLESHIP

The battleship *Kawachi*, 20,850 tons, was launched at Yokosuka on October 15. The Emperor attended the ceremony.

The *Kawachi* is the first real Japanese Dreadnought. She was commenced at the Imperial Dockyard of Yokosuka in January, 1909. When completed she will displace 20,850 tons. For armament she will carry twelve 12-inch, ten 6-inch, and twelve 4.7-inch guns, with five torpedo-tubes. The main armor belt is 9 inches thick, and the designed speed 20 knots. A sister ship, the *Settsu*, will be launched at Kure in March next.



"KAWACHI"

—From *Naval and Military Record* in *United States Naval Institute Proceedings*, December, 1910.

Short Notes

The Lake Submarines.—*The Army and Navy Journal* of February 18th gives the following distinctive features of the Lake submarine *Seal*, which was launched at the yards of the Newport News Shipbuilding and Dry Dock Co., on the 8th instant: Bottom wheels, diving compartment, hydroplanes, drop keels, anchor weights. The bottom wheels are used in shallow waters. In moving on the bottom a cyclometer gives a fairly accurate record of the distance traveled and the gauges give an absolute record of changing depths. The diving compartment provides an exit for a diver sent for investigation or for making repairs to the vessel, and it furnishes a safety chamber for the escape of the crew in case of accident. By the use of the hydroplanes the boat can be kept at a uniform depth. The drop keel permits the release of several tons of weight and a corresponding increase in bouyancy. It also increases the longitudinal stability of the boat. The anchoring weights are designed to secure immobility at any desired depth, and the vessel can be drawn to the bottom by winding in their cables. The weights can be operated without the exposure of any of the crew on deck, and, if necessary, can be cast loose instantly to increase the buoyancy of the vessel. A special form of storage cells and connections is used in the batteries of the Lake boats.

—*The Army and Navy Journal*, Feb. 18, 1911.

Wireless Telegraphy on Submarines.—The results obtained from the trials of wireless telegraphy fittings in certain submarines during last year's naval maneuvers were generally satisfactory. These trials have been supplemented by exhaustive experiments, which have further improved the fittings and rendered them sufficiently reliable to warrant their installation in all the submarines of the B, C, and D classes. These vessels are accordingly to be supplied with the improved sets of instruments and fittings. Each vessel will be provided with a mast and gaff for supporting the aerial wires, and with provision for lowering the same down level with the upper deck when not in use, together with water-tight sockets in the deck for leading the aerial wire down to the instruments. Up to the present no great difficulty has been experienced in receiving messages within a radius of about 50 miles, but hitherto it has not been found possible to send messages with the same facility, and to this part of the problem wireless experts are directing their attention. A special "tune" will be used for the under-water sets of instruments, but easily adapted to the instruments of the depot or other ships acting in support of the flotillas. With this extension of the system it will be possible for the Admiralty to maintain wireless communication with every unit of our fleets in European waters, from battleship to submarine.

—*The Engineer*, February 10, 1911.

Results of French Battle Practice.—*La Vie Maritime* gives the following tables showing the results of the French battle practice held last August, using the coast-defense ship *Fulminant* as a target. The target was stationary; the range about 7000 meters; each ship made one run past, following a leader, and firing for 6 minutes with main-battery guns only. The second squadron fired first, and it was necessary to mount wire-screen targets on the wreck when the first squadron fired:

SECOND SQUADRON

Battleships

	Shots	Hits	% of Hits	Efficiency
1. Jaurgéuiberry	95	30	30.6	33.4
2. Bouvet	149	30	20.8	22.6
3. Carnot	92	17	18.4	21.8
4. Saint-Louis	175	25	14.3	12.3
5. Charlemagne	189	25	13.2	11.2
6. Gaulois	190	14	7.4	7.5
Cruisers				
1. Dupetit-Thouars	110	37	33.6	24.3
2. Marseillaise	113	32	28.3	22.4
3. Condé	133	34	29.5	20.8
4. Gloire	136	18	13.2	10.2

First Squadron

	Hits	% Efficiency
1. Justice	20	26.7
2. Démocratie	17	22.9
3. Ernest-Renan	22	16.6
4. Patrie	26	15.1
5. Jules-Michelet	17	11.7
6. Vérité	10	11.1
7. Jules-Ferry	20	10.9
8. Liberté	7	10.4
9. République	19	10
10. Victor-Hugo	14	7.8

United States Naval Institute Proceedings, December, 1910.

New French Torpedo.—The Moniteur de la Flotte, in an article advocating the use of a very high-speed but short-range torpedo for torpedo-vessels, gives the following particulars of the latest model French torpedo: Speed, 38 knots for 1000 meters, 33 knots for 2000 meters, 28 knots for 3000 meters; extreme range, 4000 meters; deviation at 3000 meters, less than 30 meters; diameter, 45 cm.; charge, 108 kilograms; length and weight unchanged from previous model; cost, 13,500 francs, as against 12,000 francs for previous model.—*United States Naval Institute Proceedings*, December, 1910.

*Maps for Aeronauts.**—The need for maps for all air craft is set forth in an article in *La France Militaire*. The point of view of the aeronaut is so different from that to which he is ordinarily accustomed, that he must be assisted by some chart, or map, which will identify any observable landmarks.

Of first importance are the roads, railroads and watercourses, the boundaries of towns, or cities, churches and other prominent buildings. Areas favorable, or unfavorable, to aerial navigation should be distinctly indicated.

An international commission on aeronautical maps comprises members from Belgium, Germany, England, France, Italy, Holland, Austria-Hungary, Switzerland and Spain. These maps of Belgium, France and Austria-Hungary are completed. Those of Germany, Holland, Italy and Switzerland are in process of preparation, while those of Denmark, England and Spain are in prospect. In Russia and Norway, the need of such maps does not seem to be felt.

NOTICES

A EUROPEAN PARTY AT VERY REASONABLE COST

Rev. Dr. L. D. Bass and wife with Rev. Dr. Temple and wife of Boston, are to take a party to Europe in June. Dr. Temple took 556 persons to Europe last Summer. Trip to cost, all expenses, $285.00. A revolution in cost and methods, the result of ten years experience and study of the situation. Sail June 24th, travels in Italy, Switzerland, Germany, Holland, Belgium, France,

---

* Abstracted from translation made for the War College Division of the General Staff, U. S. Army, by Lieut. Herbert C. Fooks, 16th Infantry.

England and Scotland. Special features; opportunity to go ashore at Gibraltar; see the African coast; drive over the Simplon Pass; steamer trip on Lakes Lucerne, Geneva, Thun, Brienz and the Rhine; excursion to the Island of Marken; coaching through the Shakespeare country.

Dr. Bass has arranged with the Baptist Young People's Touring Club of England for his American party to join them from London to Switzerland, thus securing their special rates which are several pounds less. Any of the party can remain two or three months longer if desired without forfeiting return tickets. This party is not out to make money, therefore anyone wishing these cheap rates should write Dr. L. D. Bass, Mexia, Texas.—*Mexia Enterprise.*

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

29 West 29th St., N. Y.

Meeting in New York, April 11, 1911.

The problem of making the earth yield an increase adequate to supply the needs of the population will be considered on Tuesday evening, April 11, at a meeting of The American Society of Mechanical Engineers, in the Engineering Societies Building, 29 West 39th Street, New York, when a paper upon the Economic Importance of the Farm Tractor, by L. W. Ellis, will be presented. Following this paper Dr. Charles E. Lucke, professor of mechanical engineering of Columbia University, will give a talk on the mechanical equipment of farm tractors which will be illustrated by views taken at the Canadian Industrial Exhibition held in Winnepeg, Manitoba, last summer where Dr. Lucke represented the International Harvester Company.

MORO PROVINCE FAIR

We acknowledge, with thanks, receipt of a copy of the Special Moro Province Fair Edition of the *Manila Times*. This Fair is to be under the presidency of General Pershing, who is the Governor of the Province. The resources of the Moro Islands are described and make a most inviting prospect. Pictures of the officials and of many prominent citizens—Spanish, Swiss, Chinese, Japanese, besides many other nationalities—are shown and give an idea of the cosmopolitan character of the population of that part of Uncle Sam's territory. If such a Fair could be held in the home country, we would guarantee it a patronage never dreamed of for one of our usual expositions.

SMITHSONIAN INSTITUTION REPORT, 1909

The annual report of the Smithsonian Institution for 1909 has been issued. It is the usual handsome volume of seven hundred odd pages and containing the usual amount of interesting matter. As has been recently the custom, there are reprints of articles of scientific interest, which seem worthy of preservation. Among these, of particular interest to our readers might be mentioned "What Constitutes Superiority in an Airship," by Commandant Paul Renard, reprinted from *Revue des Deux Mondes*, of Nov. 1, 1909; "Researches in Radiotelegraphy," by Prof. J. A. Fleming, being a lecture read before the Royal Institution of Great Britain, June 4, 1909; "The Nitrogen Question from the Military Standpoint," by Prof. Charles E. Munroe, reprinted from *U. S. Naval Institute Proceedings*, Vol. 35, No. 3.

The report quotes an article on the "Smithsonian Institution" by Charles Minor Blackford, M. D., in the *North American Review* for January, 1909, as follows:

"Such has been the result of a single benefaction of half a million of dollars, and perhaps no such result has ever been accomplished by so limited an endowment. Were the great sums given to swell the almost infinite endowments of some of our universities diverted to this unostentatious establishment, its power for good would be immeasureably increased, but, as it is, the bounty of a stranger and an alien has given the American people an agency for good whose influence is incalculable. It presents an opportunity to those who wish to bestow money for come beneficent purpose such as is given by no other on earth, and its scant means and petty endowment are a reproach to our rich and generous nation."

CORRESPONDENCE

Any communication received by the Editor, which the writer desires inserted, which is signed by him and which would be of interest to the readers of the JOURNAL from a military point of view, will be published in this department. It is especially desired to have questions asked and small items of information given. Questions asked in one issue will be answered in the next, where possible, by some person, or persons, who is considered to be capable of giving authoritative information on the subject involved. Answers or remarks, regarding any such question by any others will always be very welcome. The readers of the JOURNAL (and all others interested in it or its work) are most cordially invited to make full use of this department.

DESCRIPTION OF A DEFLECTION CORRECTION DEVICE*

The inability of the gun pointer to make accurate deflection corrections based on observation of splashes has been one of the greatest difficulties encountered during gun target practices.

Most gun detachments are so well trained that the piece is loaded again before the expiration of the time of flight. The piece therefore cannot be traversed so that the vertical wire of the sight can be kept on the exact point fired at.

The result is that when the projectile strikes, the vertical wire is off the target, and the gun pointer has to make a rough approximation if his shot is off the target. This must be added to or subtracted from the deflection used. This whole process is too difficult for accurate work.

Lieutenant Malcolm P. Andruss, Commanding Fort Michie, N. Y., made experiments with a view to devising some satisfactory method of correcting deflection errors by having the gun pointer observe the splash. He reported as satisfactory a device designed by Corporal Paul Webber, 134th Company, Coast Artillery Corps, and described below:

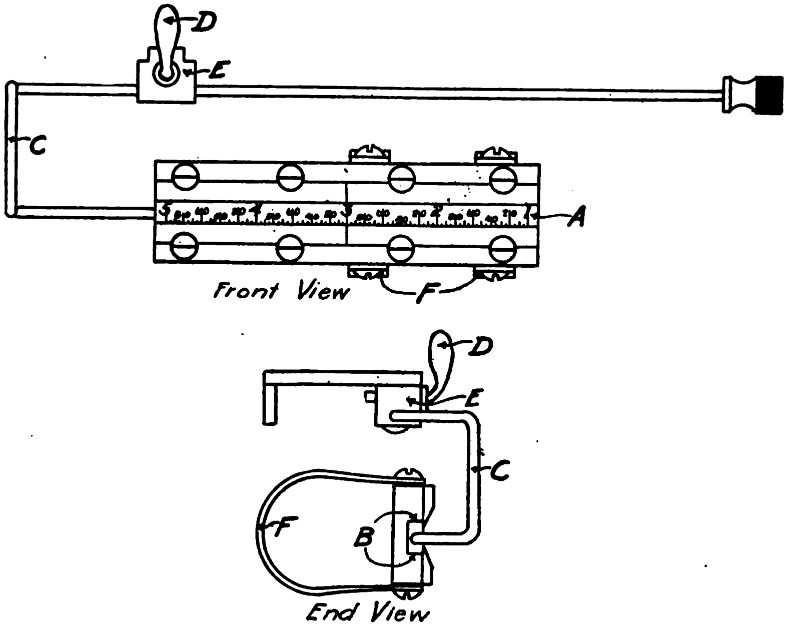
It consists of an auxiliary scale "A", worked in an undercut groove "B," which is secured by bands "F" to the illuminating receptacle of the sight deflection scale. The slide arm "C" is attached to the scale "A" and slides through a support "E" which is held in place by one of the sight deflection scale screws. The wedge clamp "D" is used to clamp the auxiliary scale "A" to the sight deflection scale. The scale "A" is graduated like the sight scale.

Operation:—

The auxiliary scale "A" is set at the deflection used on the sight scale and the wedge clamp "D," clamped. This is done so as to obviate any possibility of the shock of discharge disturbing the setting of the auxiliary scale. As soon as the piece is fired, the wedge clamp "D" is unclamped. The gun pointer follows the target with the vertical wire by turning the sight micrometer screw. As soon as he sees the splash he clamps down on the wedge clamp "D" and by means of the micrometer screw bisects the splash. The auxiliary scale being connected to the sight deflection scale by the wedge clamp "D" is given a movement corresponding to the deflection error. The corrected deflection is read and transferred to the sight deflection scale.

---

* Published on recommendation of Coast Artillery School Board, approved by the Chief of Coast Artillery.



DEFLECTION CORRECTION DEVICE

The device is simple in construction and can be made readily at any post.

BOOK REVIEWS

The Campaign of Chancellorsville.- A Strategic and Tactical Study. By John Bigelow, jr., Major, U. S. Army, Retired. New Haven, Conn.: Yale University Press. London: Henry Frowde Oxford University Press. 8″ x 11½″. xvi + 528 pages. 39 maps, 3 sketches and 5 plans. Price, $10.00 net.

This is a most exhaustive treatise not only of the Battle of Chancellorsville itself, but of all minor operations which led up to it. The matter presented was originally contained in a course of lectures given by the writer to his classes at the Massachusetts Institute of Technology in 1894 and 5, while he was serving a detail as Professor of Military Science and Tactics at that institution. As to his reasons for choosing this campaign, he says in his preface:

"I made this selection because that campaign (of Chancellorsville) presented a greater variety of military problems and experiences than any other in which an army of the United States had taken part. In no other was there so rapid a succession of critical situations. Moreover, no other one, approaching it in importance, has been so imperfectly apprehended and described."

The work is divided into two parts: "Part I, the *Period of Preparation*, covers the time from the appointment of Hooker to the command of the Army of the Potomac, January 25, 1863, to the issuing of orders for the movement of the army, April 26, 1863." Part II, *The Period of Operation*, describes the march to Chancellorsville and succeeding events to the recrossing of the Rappahannock on May 6th.

Chapter one opens with a resumé of the state of the country at the end of the year 1862. The Army of the Potomac lay at Fredericksburg, facing the Army of Northern Virginia. General Hooker's history is traced, up to the time of his appointment to the command of the Army of the Potomac. Gen. Burnside had issued an order dismissing him from the Army of the United States, for criticising his superiors and for general disloyalty. This order Gen. Burnside submitted to the President for approval, with his resignation of his command as an alternative. The order was disapproved, the resignation accepted, and Hooker given command of the Army of the Potomac. Then followed Hooker's interview with the President and Mr. Lincoln's characteristic letter to him, in the course of which the President said: "I have heard, in such a way as to believe it, of your recently saying that both the Army and the Government needed a dictator. Of course it is not for this, but in spite of it, that I have given you the command. Only those Generals who gain successes can set up dictators. What I ask of you now is military success and I will risk the dictatorship."

In Chapter II, the organization and equipment of the northern and southern armies are compared, the author concluding that the southern army was superior in organization and that their selection of officers was more judicious early in the war. Moreover, they instituted and enforced strict conscription laws. "The Army of the Potomac, on the other hand, had suffered repeated and radical changes in its organization and *personnel*. It depended for recruits upon volunteering." The number of cadets admitted to the Military Academy from 1802 to 1861 was from two and one-half to three times as great from the south, as from the north, in proportion to the white male population in each section. This is said to measure the relative amounts of military spirit in the two sections. The fact that the north supported but one military academy, (outside of West Point), while the south had nine, is mentioned as another indication of the same fact.

Chapter III is devoted to a statement of the military situation, including all troops on either side anywhere in the theatre of operations of the Army of the Potomac and the Army of Northern Virginia. The chapter ends with a quotation, the music to which a Federal band was said to have played on the banks of the Rappahannock, which separated the two armies,—which banks were, on one side, blue with "yanks" and on the other gray with "rebels." The band played first "Dixie"—and the yells of the "rebels" rent the air. "Yankee Doodle" brought forth similar yells from the "yanks." When the band played "Home, Sweet Home,"

"The sad lone stream its noiseless tread
Spread o'er the glistening pebbles;
All silent now the Yankees stood;
All silent stood the Rebels."

A short time after his assignment to the command of the Army of the Potomac, Hooker reorganized it, abolishing the four grand-divisions and substituting for them eight corps, one of these being a Cavalry corps. This the writer condemns as not sound tactically, calling attention to Grant's reducing to three corps the five which remained in the Army of the Potomac in 1864. Lee had but two corps in the Army of Northern Virginia.

Schools of instruction were instituted in the Army of the Potomac, but only in "tactics" now called drill regulations, and practical instruction in drill of smaller units. There was no attempt to give practice in command to officers who would in battle have to handle large bodies of troops.

The author is severe upon Gen. Mosby and his methods of warfare. "On his last expedition, Mosby had a number of men with him who had accompanied him on his first raid and in the meantime had lived as peaceful citizens at their homes. Such combatants are not partisans, but guerillas. Mosby himself, not holding any commission from the Confederate government, nor being in any Confederate army, had no right, if captured, to the treatment due to a prisoner of war."

Part II describes the battle with a minuteness never before attempted in an analysis of any battle in United States history. Frequent comments upon the varying situations are made, which assist materially in appreciating the strategic and tactical principles involved.

Appendices and a most complete bibliography end the volume. There is danger of seeming to laud this work too highly. In every respect it appears excellent. If there is one feature more than any other, which is worthy of special commendation, it is the set of maps, which show the exact location of all troops at frequent intervals. In many, a small map showing the whole field of operations is placed in the corner of the larger scale map, which shows but a particular part of the field. In this way, the reader keeps the general relations of the various phases in mind, while appreciating the particulars of each part.

The typography, paper and binding of the work are very handsome and would do credit to any publisher.

We wish it might have been possible to issue the work at a price more nearly in reach of any and all who are interested in the study of military history. At the price of this edition, the work can appear only in libraries and in the private collections of persons of more means than possessed by the average student of such subjects.

It is to be most devoutly hoped that Major Bigelow will not be content to rest here, but with the same thoroughness and ability will investigate others of the interesting campaigns of our Civil War.

Engineering Abstracts. Published by The International Institute of Technical Bibliography, 57-58 Chancery Lane, London, W. C. 6½″ x 9¾″. Paper. Price: One section 24 shillings yearly; all seven sections 80 shillings, postfree.

"The International Institute of Technical Bibliography has been founded to promote and organize an international registration of all engineering knowledge in connection with the National Sections of the Institute already formed in France, Germany, and Austria, and in course of formation in several other countries.

"This object is attained as follows:

1. By the publication of a fortnightly Journal, *Engineering Abstracts*, which covers the entire field of engineering and technical science, abstracting or indexing all articles of scientific or technical value appearing in the technical periodicals, Proceedings of learned societies, etc., all over the world. Thus, more than 100,000 books and articles are abstracted or indexed annually. This journal forms, therefore, the most complete technical index yet published. For the sake of convenience, it is divided into 6 sections, dealing with Mechanical Engineering, Electrical Engineering, Civil Engineering, Mining and Metallurgy, and Applied Chemistry respectively.* The sixth section (Supplement) contains all articles of miscellaneous character which cannot be brought under any of the above headings.

2. By supplying to its members any information required, of either a literary or technical nature. In this connection the Institute would undertake:

   a. To search for and obtain for its members any books or articles, or generally any information which may have been published on a particular subject in any language.

   b. To obtain general technical information, such as details of processes and methods of manufacture, or answers to theoretical and practical questions on any particular subject, etc."

The above is from the prospectus of the abstracts as issued by the International Institute of Technical Bibliography. In the abstracts, each item gives full title, name of author, date of publication and a short *resume* of the contents, where the title does not indicate it sufficiently. In the case of books, publisher, size and price are also given. Each title, abstract, etc., is given in the language of the original.

---

* To these are now added a seventh section, *Military Abstracts*.

The object of the abstracts is certainly worthy of encouragement. The manner of execution of the plan appears to be good. The abstracts comprise "about 3000 pages annually and give more than 100,000 abstracts of technical books, papers, etc., compiled from more than 100 periodicals of all countries."

There are two respects in which it would seem that this publication falls short. First, a person using it must be able to read each language which is represented by a reference. Some may be able to read them all, but many cannot. If each reference were translated into English, as well as appearing in its original language, the usefulness of the abstracts would be increased. Secondly, to find whether an article has appeared on a given subject during any year, one must look through each of the twelve issues of that year. If the complete contents for the year were cumulated in the December issue, the ease of reference would be much increased.

Such a work as this is essential, if one is to keep abreast of any of the engineering professions. The connection of the English branch with the various European branches should help materially in making it complete. The list of periodicals quoted seems to be very complete, tho there is no list of them given.

Nautisch-technisches Worterbuch, Vol. II, Part 2 (L to Z),—English, French, German and Italian, and French, English, German and Italian. Compiled under direction of the Mitteilungen aus dem Gebiete des Seewesens. 6¾" x 9½". xiii plus 1115 pages. Not illustrated. Cloth. Price, per volume, 5 dollars.

This volume has just been issued from the press of Ig. v. Kleinmeyer and Fred. Bamberg, Laibach, Austria-Hungary. It comprises 1115 pages, compiled by the *Mitteilungen aus dem Gebiete des Seewesens.* There have preceded this, Part I and a supplementary volume, both compiled by Rear Admiral Julius Heinz, retired, of the Imperial Austro-Hungarian Navy. This volume contains, English and French words arranged alphabetically throughout. Under each, is its equivalent in the other language and in German and Italian.

The various meanings which a word may have are classified very carefully, special meanings following the first general definition. For example, under "torpedo" are found the equivalent words in the other languages. Then follow the classes of torpedoes—dirigible, dummy, spar, etc.—and these are followed by twenty-three pages of phrases in which the word torpedo is commonly used, names of the parts of torpedoes and the general terminology of it and its use.

Where a word in either language follows its equivalent in the other, instead of repeating all the phrases in which it appears, references are made to the place where these may be found under the equivalent.

The thoroughness of the work and its broad and complete scope are indicated by the number of pages devoted to the word torpedo, alone—twenty-three, as given above. There are eighteen pages devoted to "machine," thirteen to "mast," etc.

As far as can be judged from the volume under consideration, this is an excellent technical dictionary and one which would materially assist anyone doing work involving translation of the languages for which it is made. It is essentially naval, but treats well both military and scientific topics, trades and branches of industry. While of prime importance to the naval officer, it is likewise very valuable to the engineer, mechanic, electrician and artillerist, as well as to all who take an interest in maritime affairs.

Due to the fact that the work was far advanced when the orthographic change in the German language took place, it was not incorporated in the work.

The rendition of the foreign expressions was given great care. The English expressions of the dictionary were revised by Admiral Sir Richard Ed. Tracey, K.C.B., and Lieut. I. A. Duncan; the French by Commander Jacques Chardon and Lieut. E. H. Sombron; the Italian by Captain Marchese Alfredo Lucifero.

Mountain and Colonial Artillery. By Major-General R. Wille, I.G.A. Berlin: R. Eisenschmidt, Verlagsbuchhandlung, Dorotheenster, 70 A. 6½ x 9½. x plus 177 pages. 127 il. and 12 plates. Price: cloth, 15M; paper, 13M.

This is a very recent publication, bringing its subject down as nearly as possible to date. The work itself is followed by an appendix of 16 pages in which differential recoil is discussed. The 127 cuts and 12 large plates are excellently executed. They show various views of each gun and carriage described and give a good idea of each. The guns illustrated include the 40 m.m. colonial gun; mountain guns of 6.72 c.m., 7.5 c.m., 8 c.m., 65 m.m., 70 m.m. and 75 m.m.; and mountain howitzers of 10 and 11 c.m. With each description are the names of the coutries in which that gun has been adopted and the names of the firms who make it.

The author begins by treating the subject in general, dwelling on the progress and development of this branch of the artillery and the difficulties encountered due to the conflicting requirements in the solution of the problem. Then follows a review of the systems of guns of these sorts in 19 different countries. It is characteristic of all German works that 17 or 18 pages are devoted to the systems of these guns in England and in France, while 6 lines suffice for the German Empire's equipment.

The firms who make these guns are next given, with an accurate description of the product of each. They are Chatillon & Commentry, Ehrhardt, Krupp, Schneider, Skodawerke, and Vickers-Maxim. The gun, breechblock, elevating, sighting and traversing mechanisms, carriage and accessories are minutely described. Tests at the factory and in the field of the ballistic and other qualities of each are detailed.

The author has treated the subject exhaustively. This treatment in conjunction with the illustrations, tables, critical reviews and discussions, will prove a valuable source of information for anyone interested.

The Battle of the Wilderness. By Morris Schaff. Boston: Houghton Mifflin Co. 5½ x 8½. 345 pp. Five maps and plans. 1910. Cloth. $2.00 net.

Whatever this author has written has been well done and has repaid a careful reading; for his works always reveal diligent preparation and the author has only undertaken subjects for which experience and ability have made him a specialist and a most accurate historian.

The Battle of the Wilderness has not had the same importance assigned to it as many other less worthy engagements, simply because fewer writers of military ability were in a position to undertake the difficult task. Now and then some author has given us a glimpse of a dramatic scene, but the real purpose of the battle and its uncertainty of result have been usually clouded, or the importance of the engagement has faded in the triumphant light of Gettysburg, the victory of Antietam, or the pathos of the final act at Appomattox Court House.

Morris Schaff recognizing the vital significance of the battle has performed a notable task for all generations in recording his experiences and military opinions, and has added another valuable contribution to the literature of the Civil War. His splendid description of the chief actors in its bloody drama, his word paintings of the crucial movements, his epitome of the results attained by the battle and their effects on the outcome of the whole war, reveal a man of unusual breadth of observation, a keen judge of character, a poetical mind of rare grace and imagination, and a fluent master of words.

Some photographs caught amid the ebb and flow of the American Conflict give us fixed glimpses of great characters in its awful panorama, which we all deeply appreciate, but after all, the camera only presents a few poses in black and white at which we glance and which we then stow away among our treasures. But the word paintings, the everlasting, flesh tinted, speaking reproductions of the War's great commanders, by Schaff—these are the portraits the author has given us in the gallery of his noteworthy volume. Grant, Meade, McClellan, as they actually were—now all can realize that Grant was no mere "butcher of men," as they gaze upon the sad and plaintive melancholy of that face amid the carnage of this battle. We appreciate the lofty personality of Lee as he dashes into the forefront of battle—the heroism, the bravery and recklessness of Hancock—the skill, the power and the spirit of Meade. Fascinated we read of the great magnetism of McClellan, and feel it too, as we hear Schaff tell of the merry laugh of the "great organizer" as he shares the mess at Fort Monroe; and so of character after character—the whole book enchants us and holds our interest to the end.

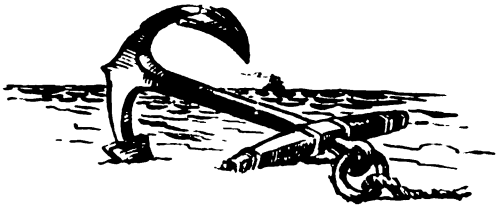
In addition to the battle, the author has introduced in appropriate places graphic views of the times, showing us how gloomy were the prospects for the triumph of the North, what golden chances seemed to light up the banners of the South; the words of the writer are clear and forceful—"At the end of three years of desperate war, she was staggering under a mighty debt, the Confederate cruisers had driven her commerce from the sea, volunteering, which had begun spontaneously and with burning enthusiasm, had stopped, and the administration had been forced to resort to the draft. Successive defeats had bred factions within and without the cabinet,—factions made up of governors, editors, and senators, all secretly denouncing Mr. Lincoln and his administration, and actively plotting to defeat him at the forthcoming convention. To make matters worse, the government, fretted by repeated reverses, had become more and more irritable and, as was natural, with the continuance of the war, more and more arbitrary. Those in official life who criticised its policies were turned upon fiercely; the press, never an easy friend or foe to deal with in time of peril, was threatened with muzzling, and some papers were actually suppressed and their proprietors imprisoned; the provost marshals, of necessity invested with wide but delicate military authority, often became despotic in their arrests, and almost habitually haughty in parading their office,—their haughtiness aggravated by ignorance, vanity and bad manners. Under it all, discontent had grown and spread, until, by the time the campaign of 1864 was ready to open, in the states bordering on the Ohio there was a secret organization said to have had over four hundred thousand members, a coagulation of all phases of political hatred and tainted loyalty, only waiting for a substantial defeat of the Union army to break out into an open demand for an armistice, which, of course, meant the recognition of the South."

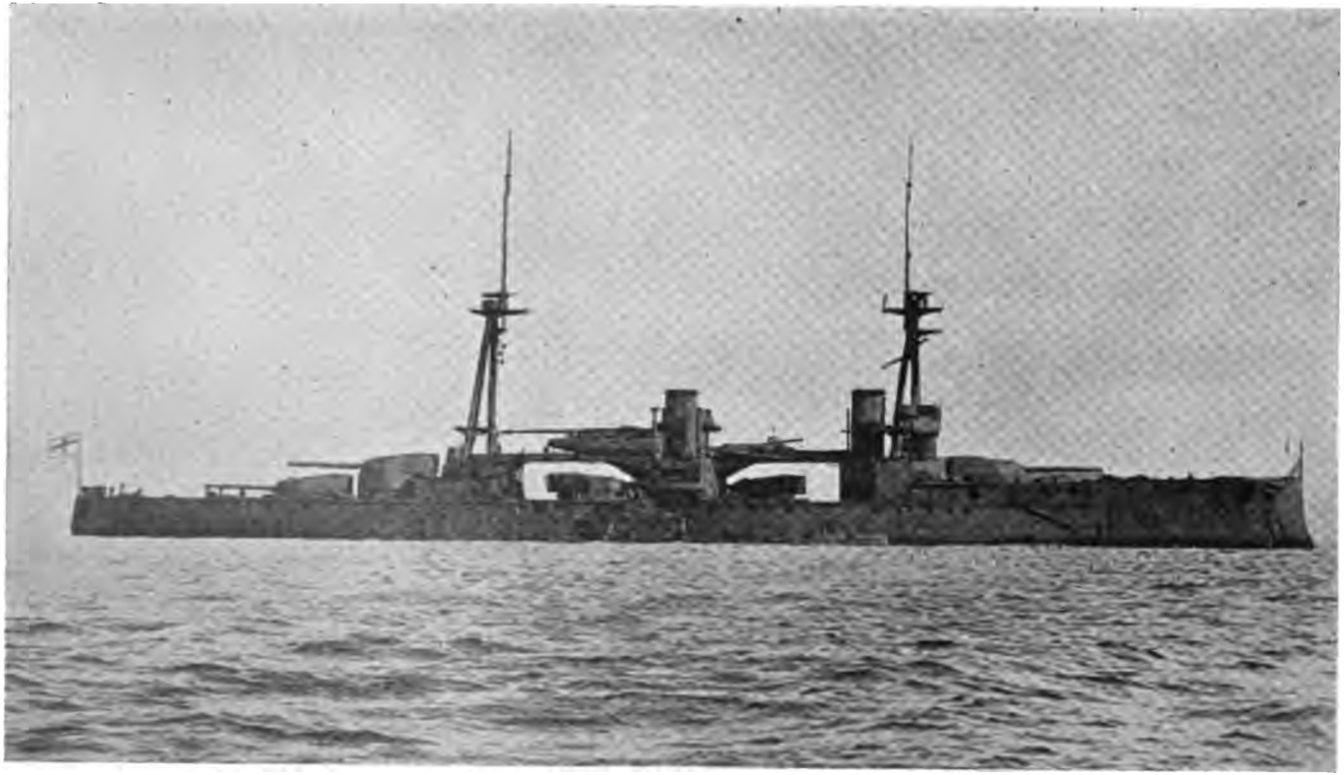
The army has ever been proud of the great leaders who have helped to weld our nation into this great Republic. But the army ought to be equally proud of those who having endured the fury of the fray, have in their riper years of peace, following the inspiration of Zenophon, Herodotus and Julius Caesar, written for coming generations the history of the scenes of which they have been witnesses.

Taschenbuch der Kriegsflotten. XII. 1911. By B. Weyer, Kapitan-leutnant a. D. Munich, Germany: J. F. Lehmanns Verlag, Paul Heyse-Strasse Nr. 26. 4½" x 6¾". 541 pp. Numerous cuts, sketches, silhouettes and plans of ships. Cloth. Price, M 5.

This twelfth edition of the *Naval Handbook* for 1911 by Lieutenant B. Weyer, retired, made its appearance shortly before Christmas. It faithfully portrays the prodigious development of the navies of the world and exhibits a great amount of labor and diligence in its execution. Several modifications are noticed from the 1910 edition, among which are the omission of aerial navigation; the addition of a review of the maritime interests for the past year of the German Empire, with especial reference to German-English commercial relations; and a comparative review of the armament of the latest ships of the line and armored cruisers, on deck plans, which is very instructive. An article likewise forecasts an increase in caliber in large guns to 14-inch, stating that the Krupp method of constructing such calibers is superior to the English method. Aerial navigation was omitted, as the development was so great during the past year, it was recognized that the great mass of data could no longer be properly handled in an appendix, so a separate publication was decided upon, which treats the subject in its manifold phases and which was issued at the same time as the Handbook. The data is corrected to the beginning of December, 1910. The book is copiously enriched by cuts, sketches, and silhouettes of ships, showing the increase of all the larger navies. Especial care was excercised in verifying all data given.

The Handbook contains many instructive tables, comparisons, and reviews, which can scarcely be found anywhere so conveniently arranged. This is a feature which every one who has occasion to use such a book can appreciate. It is of convenient size and shape for ready reference.





Photograph by Stephen Cribb, Southsea.

H. H. S. NEPTUNE

Displacement, 20,600 tons; length, 540 feet; beam, 86 feet. Armament: 10, 12-inch, 50-caliber; 20, 4-inch; 3, 21-inch submerged torpedo tubes. Fires 10, 12-inch on either broadside; 8 dead ahead and 6 astern. Armor (Krupp), 12-inch belt. Speed, 21 knots. Parsons turbines and Yarrow boilers.

JOURNAL
OF THE
UNITED STATES ARTILLERY

*"La guerre est un métier pour les ignorans
et une Science pour les habiles gens."*

VOL. 35 No. 3 MAY—JUNE, 1911 WHOLE No. 109

First Prize, Essay Competition of 1910

THE ORGANIZATION AND TRAINING OF COAST ARTILLERY TROOPS, INCLUDING RESERVES AND SUPPORTS, WHICH WILL INSURE THEIR MAXIMUM EFFICIENCY IN TIME OF WAR, AFTER THEIR WITHDRAWAL FROM THE COAST FORTIFICATIONS.

BY LIEUTENANT FRANK S. CLARK, COAST ARTILLERY CORPS

The solution of the problem presented by this subject demands, primarily, a consideration of the causes which would necessitate or justify the withdrawal of coast artillery troops from their normal province, the coast fortifications.

Inasmuch as the duty of coast artillery troops, as well as the reason for their existence, lies in the service of the coast fortifications, the only possible justification for their withdrawal therefrom must result from circumstances incident to the operations of a particular war, rendering unnecessary the protection of portions of the coast line, including the harbors and cities thereon. Such circumstances could occur under either of the following heads:

1. Our mastery of the sea on one coast or another, due to the initial lack of a hostile navy, or its subsequent destruction by our own navy.

2. The capture from the land side of particular cities or harbors, thus rendering the further defense of their sea-fronts of no value.

3. The capture of a coast fort in any district whose guns command other forts in the same district so as to make their ultimate reduction inevitable.

In the first case, all coast artillery troops on the unmenaced coast, with the exception of a very small garrison for the guard and police of each post, could be withdrawn for other service, *probably* on the other side of the continent, and either to strengthen the coast defense there, or to reinforce the mobile army.

In the second and third cases mentioned, all the Coast Artillery troops would be quickly withdrawn, and made available for field service with the mobile army, *probably* in the immediate vicinity, to assist in driving out the invader, and recapturing the lost city or fort.

It will be seen then that in time of war causes might arise demanding the withdrawal of a portion of coast artillery troops, including reserves and supports, from the coast fortifications. If, as in the first case noted, this cause resulted from our mastery of the sea upon one coast, and the coast defense upon the other coast was being hard pressed by the hostile navy, the proper use of the released troops would be to throw them into the besieged forts as a second, and possibly a third, relief. But let us suppose that the United States is at war with an Asiatic power, which has crossed the Pacific successfully with a fleet and a land force. The object of the enemy is not so much to invest, capture and destroy the rich seaport cities on the Pacific coast, as to quickly land with troops and overrun the Pacific slope, pushing eastward to the mountains and seizing and holding the mountain passes through which pass the transcontinental railways. In such operations as these, time would be an important factor in the plans of the enemy. To silence or capture our coast fortifications would be a task which would consume too much time at the beginning of these operations, so deferring it until the rear of the fortifications had been effectually cut off, the enemy would employ a sufficient portion of his navy to contain and occupy the garrisons in the coast forts, and landing his troops at convenient points along the coast, would push them rapidly inland. Such a war might find the Atlantic coast totally unmenaced by any fleet, either of the enemy or his allies. While the coast artillery troops thereby liberated from the Atlantic coast, would be urgently needed on the Pacific, it is manifest that the need for them would not be as coast artillery troops, but as troops of the mobile army, for immediate field service. To successfully meet the need of the hour, they would require to have received field training in one of the mobile arms of the service. This hypothetical situation is inserted, as one of many, to emphasize the fact that in this country coast artillery troops should be prepared, after their withdrawal from the coast fortifications, to take the field as a part of the mobile army.

The organization and training of coast artillery troops to provide for such possible field service should be determined by balancing the following limiting considerations:

1. The arms of the mobile service which upon a war footing would be proportionally weak are the ones to receive reinforcement by this means if possible.
2. The training of coast artillery troops in coast defense being of first importance to them, any other training to be given them must be of such a character as to interfere the least possible with training in coast defense.
3. The small area for field training open to the use of many coast artillery companies is a very limiting consideration in the problem.
4. The expense of providing and maintaining the equipment for field training in some arms of the service for so large a body of men as the present Coast Artillery Corps might be so great as to prove prohibitive of the whole scheme.
5. In so far as the nature of the field operations to be engaged in could be anticipated, their needs should be provided for in the training to be given coast artillery troops.

Before weighing these considerations in detail, let us digress slightly to determine whether the solution of the whole problem is identical for application to the integral elements of coast defense, namely, the Regular Coast Artillery, the Coast Artillery Reserves and the Coast Artillery Supports.

Very apparently the solution would not be identical, for coast artillery supports, when organized, are to consist of bodies of mobile troops,—infantry, cavalry and field artillery,—assigned to the task of defending the coast fortifications from the land side by the usual field operations devolving upon those branches of the service. Therefore, so far as coast artillery supports are concerned, this problem resolves itself into the simple question of providing means for quickly detaching such organizations from their duties with coast fortifications, and attaching them for service with units of the mobile army. In their case, it is only a question of place, as their duties, and consequently their organization and training, would not alter for either service. As the organization of coast artillery supports has not yet been undertaken, no attempt to provide for their withdrawal from the coast fortifications can be made as a part of the solution of the present problem.

Now, as between regulars and reserves, is the solution identical? There are some reasons why it would appear to be so. The first object of both is to shoot to hit with big guns. In the best of the reserve organizations, as in the regular coast artillery, this artillery spirit dominates other military motives. While the reserves have not the time sufficient to master coast artillery science as completely as the regular corps has done, yet they have the ambition which is leading to efficiency. On account of fostering this unity of feeling and ambition shared by the regulars and the reserves, there are many officers of both regulars and reserves who would look with disfavor upon any attempt to differentiate between the training for field service to be given regular coast artillery and reserve coast artillery, as tending to discourage the reserves in their efforts to pattern after the regular standard. However, in spite of this very serious objection, a closer survey will reveal the fact that conditions differ sufficiently in the two services to warrant the separate consideration of the present problem as applied to each. In the first place, nearly, if not all, coast artillery reserve organizations have seen service—in many cases active war service—as infantry. Therefore, if any transition were necessary from coast artillery to some other branch, infantry would be the logical one for them to revert to, especially as even the most forward organizations in artillery efficiency, retain a zest for small arms practice and infantry maneuvers which exceeds the enthusiasm for these matters observable in the regular coast artillery. And again, under present conditions, members of reserve organizations deprecate the lack of time to absorb sufficient coast artillery training. How then could they be properly joined with regulars in field service, if this training for the regulars should be desired in an arm of the service totally new and untried to either, but which the regulars, available twenty-four hours a day could find the time to undertake?

Altogether then, it seems proper to assert that, whatever field service might be required of the regular coast artillery, the field service to be required of coast artillery reserves under like conditions should be in the infantry arm. The organization and training of coast artillery reserves to insure their maximum efficiency in time of war, after their withdrawal from the coast fortifications will then be such as to allow them to quickly take the field as infantry. The present organizations of coast artillery reserves are nearly all designated the Coast Artillery Corps, or Districts, of their various states, and are, to all intents and purposes, either regimental or battalion organizations. In fact they were regimental organizations prior to their transfer from infantry to artillery, and in most cases, the regimental organization is but little modified. In any event, a little peace time paper work of assigning companies to battalions, and field and staff officers to their positions would make the present organizations complete. In view of the uncertainty as to how many, if any, of the reserves, would be withdrawn from the fortifications in time of war, no steps are feasible or desirable, looking to the organization of units larger than the regiment. The training of the reserves for this possible field service should be in the nature of retaining to them the knowledge of infantry work that they now possess. Small-arms practice should be pursued diligently, and infantry drills in close and extended order should form a considerable portion of the work to be covered in the armory drill season. In the subjects embraced by the promotion examinations for officers the following should be retained and emphasized: Field Orders, Infantry Attack, Security and Information, and Military Hygiene. Lastly, at least once in five years, all the reserves should attend a camp of instruction with troops of the mobile army, if necessary, foregoing the annual tour of duty at the forts for this purpose.

Let us now decide whether this solution of the problem, as it concerns the reserves, sufficiently meets the requirements of the five limiting considerations we have previously enumerated.

As to the first we admit at once that the infantry is not the arm of our service which is proportionately weak either upon a peace or war footing, and so acknowledge this condition is not well met, only asserting that the other considerations are so well fulfilled as to outweigh any importance attaching to this fact.

The second consideration is entirely satisfied by this solution, for, as we have shown, the training of coast artillery reserves for field service as infantry is the field training that would interfere the least with their training in coast defense.

The third consideration is one that applies possibly less to the reserves than to the regulars, but at any rate, however limited the area available for the use of any reserve organization, it is undeniable that at least the rudiments of infantry training can be given on a much smaller drill ground than can the rudiments of either field artillery or cavalry training.

The question of economy presented by the fourth consideration is also very well answered by this solution of the problem, for indeed, there would be no additional expense for providing equipment, as all the reserves are at present armed and equipped as infantry, and the maintenance of infantry is less than that of any other arm.

Without going very deeply into the question of the probable nature of the operations in our next war, suggested by the fifth consideration, it is sufficient to observe that the total of reserves now organized and expected to be organized, as given by the Report of the Chief of Coast Artillery, 1910, amounts to 151 companies. Supposing they could all be thrown into the field, this would give a little more than twelve small regiments of infantry, which could not come amiss in any operations this country might undertake.

Having now briefly disposed of this problem as affecting coast artillery reserves and supports, we can approach its application to the regular coast artillery with the particularity of attention that this phase of the question deserves.

Quoting again from the report of the Chief of Coast Artillery, 1910, we find that the authorized maximum strength of the Coast Artillery Corps is 701 officers and 19,321 enlisted men, or a total of 20,022 officers and men. The present authorized strength of the regular infantry is 1,530 officers and 25,231 enlisted men or a total of 26,761 officers and men. Therefore the authorized strength of the Coast Artillery Corps is about seventy-four and a half per cent. of the present authorized strength of the infantry—the bulwark of our mobile army. Consequently if any considerable portion of these coast artillery troops could be detached for field service, their increment, by its very weight, would produce a profound effect on the fighting line. It may be then, that the addition of part of the regular coast artillery to the mobile army would add a large percentage to the field force. This reinforcement might prove a stimulus or a drag, according as it was able or not to blend into the requirements of the occasion. If coast artillery troops in the field should fail in mobility, they would be not only useless but a great evil, because by their very numbers they would clog and clutter the theatre so that other troops could not maneuver rapidly or advance or fight with dash and freedom. Because then, of their very numbers and mass, it is important to select with care the organization and training to be given Coast Artillery troops so that in taking the field they may carry to the fighting line the maximum of momentum and energy.

The arms of the mobile service which could call for reinforcement in war from the Coast Artillery Corps are Infantry, Cavalry, Field Artillery, Engineers and Signal Corps. Let us weigh the demands of each arm by the standard of our previously asserted limiting considerations, in turn.

1. What arms of the service would be proportionately weak upon a war footing?

As a basis for this inquiry, let us see the proportion of all other arms, regulars and militia, to infantry. Our total infantry force is made up as follows:

Regulars	30	regiments.	
Militia	141	"	
" 9 separate battalions	3	"	
" 8 separate companies plus 151 Cos., C. A. Reserves	13	"	(about)
Total	187	regiments	

Following closely the normal composition of a division as given on Page 12, Field Service Regulations, 1910, we find that $\frac{187}{9}$ would give about 20 divisions as far as the infantry component is concerned. For these 20 divisions only, laying aside the possible demands for extra cavalry divisions, reserve field artillery, and communication troops, we would require the following:

Cavalry	20 regiments
Field Artillery	40 "
Engineers	20 pioneer battalions
Signal troops	20 field "

At the present time, of cavalry we have:

Regulars	15	regiments
Militia, (slightly over)	5	"
Total, (over)	20	regiments

In other words, in our service this arm of the service is not proportionately weak, and its demands can therefore be dismissed from this discussion.

Of Field Artillery we have:

Regulars	6 regiments
Militia, (the equivalent of)	8 "
Total	14 regiments.

As for 20 divisions we would require 40 regiments of field artillery, we are just 26 regiments, or 156 batteries *short.*

As a pioneer battalion of engineers consists of three companies, we now have the following equivalents:

Regulars	4 pioneer battalions
Militia, (about)	8 " "
Total	12 pioneer battalions

For our 20 divisions we would require 20 pioneer battalions, so we are *short* about 8 battalions or 24 companies.

As a field battalion of signal troops consists of 2 companies, we now have the following equivalents:

Regulars	6 field battalions
Militia, (about)	8 " "
Total	14 field battalions

As 20 field battalions would be required, we are *short* about 6 battalions, or 12 companies.

Comparing these results, we see that the field artillery is proportionately much weaker than any other arm of the service, and from the standpoint of the first consideration should receive reinforcement from the regular coast artillery.

2. What training can be given companies of the Coast Artillery Corps which will not interfere unduly with their training in coast defense?

First of all under this heading, as the field artillery is proportionately weak, can coast artillery properly receive training as field artillery? If by field artillery we mean light or horse artillery, most certainly not, for the problem of light artillery is altogether different from the problem of coast artillery, with the solutions widely different for each case. The problem of coast artillery is to make direct hits from fixed positions upon rapidly moving, compact targets, securing bursts only upon impact, either with or without penetration. The problem of light artillery is largely to secure the burst in the air, by a time fuze, of a shrapnel projectile, making hits by the dispersed fragments upon quite stationary, attenuated targets, from hastily chosen, temporary positions. In light artillery, range-finding and adjusting the height of burst, together with indirect laying, are problems which depend very largely upon the personal equations of practice, experience and good judgment, and as these qualities cannot be replaced to the extent that they are in coast artillery by the mechanical and mathematical equivalents of horizontal base lines and modern precise position-finding apparatus, in order to be efficient, the qualities of good judgment and experience must be maintained by unremitting practice. Furthermore the success of light artillery depends largely upon a knowledge of horses and mastery of horsemanship. This knowledge and mastery are also accomplishments involving the personal equation through long experience and daily exercise. Light artillery in campaign must either fulfill its function with efficiency or else it is a menace to the other arms by being a thing to be protected lest it fall to the use of the enemy, and by clogging the roads needed for other transport. Therefore if coast artillery is to venture into the field of light artillery, it must be as good as our regular light artillery else it were worse than useless. To become as good as our light artillery could not be accomplished with the devotion of less time than is occupied by the regular light artillery. Our light artillery devotes all its time to this training, and as the coast artillery cannot do so and perform its coast defense duties as well, the use of coast artillery as light artillery at once appears impossible.

However, there is one department of field artillery whose problem is closely related to that of coast artillery, namely, heavy, or siege, artillery. Siege artillery is charged with the shelling of positions, generally by high angle, or at least, curved fire, from a concealed, carefully chosen and prepared position. Only slight modifications in the fire-control methods they are trained to would be required of coast artillerymen in serving this class of field artillery. Moreover, while horses are a necessary element in siege artillery duties, yet neither rapid movement nor riding are demanded, and it is in rapid movement and riding that care and skill must be used to avoid injuring and wearing out horses. Consequently it would appear feasible for coast artillerymen to acquaint themselves with siege artillery *materiël* and duties in the field, sufficiently well to render them efficient enough for this service in war. Indeed, such training is contemplated by the present Field Service Regulations, for on page 29 it is stated that "In addition to its duties as outlined above, the personnel of the Coast Artillery Corps, as far as practicable, will be instructed in the management of siege and heavy field artillery."

In addition to the possibility of training coast artillery troops for field service as siege artillery, infantry presents itself as an arm whose training for field service could be given to the coast artillery without prejudice to coast defense duties. At the present time coast artillery troops are equipped as infantry, even to field equipment, and regularly receive instruction in infantry drill, tent pitching and small arms practice. In order to render the Coast Artillery Corps an efficient body of infantry, it will be necessary to elaborate this instruction to include extended order, attack formations, advance and rear guards, and outposts, supplemented by an annual period of field training, to teach men and officers to care for themselves on the march and in camp, to make proper use of cover, including intrenchments, and to practically apply such tactical principles as the officers should be required to master by individual study prior to the period of field training. This garrison infantry training can be accomplished without the expenditure of any more time than at present, by so modifying the instruction order that daily parades would not be required, thereby giving time enough for drills in extended order, outposts, etc. For instruction purposes one parade a week is ample, which could well be the present weekly evening parade. In a modern army, with so much real instruction to be given and received, the daily repetition of a formal ceremony so barren of military or patriotic virtue as parade, amounts to a sinful waste of time. For all other infantry drills, service uniform should be worn, and every effort made to have the instruction of a progressive and practical nature.

The annual period of field training should last three or four weeks, and during this period all other duties should be suspended. Few coast artillery officers will doubt that a time in each year could be so chosen, and the artillery instruction so provided for accordingly, that both infantry training and artillery instruction might be attained without prejudice to either.

To recapitulate under our second consideration, it is possible that field training could be given to coast artillery troops in siege artillery and infantry without undue interference with their training in coast defense.

3. The arm of the service part of whose field training can

be taught in the most limited area, is the infantry. In fact, to anyone familiar with the situation of many coast artillery posts, it is apparent that their garrisons could undertake the work of no other mobile arm of the service than the infantry.

4. It is very probable that any proposition for the Coast Artillery Corps to do double duty and enhance its value under any conditions of war, would not commend itself to the Congress, if attached thereto were any conditions involving much expense for additional equipment for this body of men. While there are stored at various arsenals complete battery equipments for a considerable number of batteries of siege artillery, yet to provide battery equipment and guns sufficient for the whole Coast Artillery Corps would involve prohibitive expense. On the other hand, the Coast Artillery Corps is completely equipped at the present time for field service as infantry.

5. The consensus of military opinion seems to indicate that if the United States is to engage in any war within the next generation, that war will be a defensive one with its theatre either on the Pacific slope of the United States, or in Hawaii, or the Philippines. In any case the enemy could be expected to assume and maintain the offensive to the culmination of operations, either by victory or defeat. In operations against such an enemy, siege artillery would have a poor objective, and few opportunities to get into action, while it might easily prove a serious embarrassment. If it fell into the enemy's hands, it would prove valuable to him in searching out the positions of a foe on the defensive. On the other hand, wherever the enemy operated, an excess of infantry to oppose him would be impossible, and if he chose to operate in a mountainous country like our western coast, the more infantry we could throw in to oppose him, the less chance would he have of getting far enough from the coast to sieze and hold the mountain passes.

The result of weighing all these considerations seems to point quite conclusively to the propriety of using companies of the Coast Artillery Corps as infantry after their withdrawal from the coast fortifications, and somewhat less surely to the suitability of using some coast artillery companies as batteries of siege artillery. There remains then the necessity for prescribing the essential details of organization and training to accomplish these purposes.

In order to provide opportunity for instruction in siege artillery *materiél* and duties, there should be transferred from the arsenals one complete battery equipment of siege artillery to each of the twenty-one artillery districts in the United States having a garrison of two or more companies. This battery should be housed at a mainland post in the district. At all times the equipment should be cared for and kept ready for service by a caretaking detachment, detailed from the companies, under charge of the district ordnance officer. During the open season each company in the district would be annually detailed in succession for a period of instruction in the service and nomenclature of the battery, of from three to six or more days, depending upon the number of companies in the district, and the time available from other duties. This instruction should be conducted by the company officers and noncommissioned officers, under the supervision of the district ordnance officer. An annual target practice allowance for each battery should be provided, and when all companies in the district had completed their periods of instruction, target practice should be conducted, the manning party being obtained by details of selected officers and noncommissioned officers, and privates from each company. One or more guns would be hauled into position from which the field of fire could not be seen, and then be required to go into action against a pyramidal target anchored off-shore; the target to be anchored after the guns had started into position. The battery commander would be required to direct the fire of the battery by field telephone or other means forming part of the battery equipment, from an observing station chosen after the battery had gone into position.

The horses for the necessary hauling of guns and carriages to be furnished from quartermaster stables in the district. All officers in the district, and as many enlisted men as possible should be required to witness this practice. The nomenclature and service of the siege gun supplied should form part of the requirements for qualification of first class gunners. Other than the temporary details indicated, no change in the present organization would be required for this instruction. It is believed that the service of siege artillery is so similar to the service of coast artillery that this limited amount of instruction would be sufficiently supplemented by the regular coast artillery training, and by prescribed study on the part of officers of the function of siege artillery in war, to accomplish the purpose desired.

The nature of the elaboration of the present infantry instruction of coast artillery companies in order to prepare them for efficient field service has already been indicated in this discussion. The changes in the garrison training involve the general principle of substituting extended order drills and field problems for close order drills and ceremonies. Too much emphasis can hardly be laid upon this matter. A great deal of discussion has appeared in recent months regarding the extent to which regular army methods can wisely be applied to the training of the organized militia. The gist of this discussion seems to be that inasmuch as the organized militia, having so little time, must neglect some part of its training, it is wiser to neglect the formalities and showy precision of parades and other close order drills, than to neglect the drills and details of training which the militia would need to know on the battlefield and bivouac. In a way, this discussion points the same moral to the Coast Artillery Corps, in its effort to assimilate somewhat of infantry training. The present daily drill period is almost ample for this purpose, if rightly used. However, on account of night drill on the day either preceding or following, there is one day in each week when there is ordinarily no artillery drill. The infantry drill on this day could well be extended sufficiently to afford the time for the working out of some tactical problem of a character to benefit both officers and men. Furthermore the importance of small arms practice might well be properly emphasized by granting extra pay to men qualifying as marksmen in Special Course "A." Even one dollar a month attached to this qualification would result in changing the very prevalent attitude of coast artillerymen toward small arms practice from one of bored impatience at an annual week of wasted time, to one of interest and endeavor to learn to shoot. At the same time, this course as at present laid down, is sufficiently difficult to prevent a large increase in the annual budget by the number of marksmen qualifying.

In order to gain the most practicable benefit from the annual period of field service, it is probable that the best plan would be to send the companies, as many as possible at a time, to the several maneuver camps now regularly conducted for the mobile army and organized militia. Here officers and men would rub elbows with the regular infantry, and thus pick up by imitation the practical little details, the possession of which makes infantry efficient, and the attainment of which cannot be had from books. Here also, coast artillery companies would see the cavalry, field artillery, signal corps, and engineers at work, and altogether would have the best opportunity to catch the spirit of field service in the short period they can afford to spend in such work. There can be no doubt that the annual active field service would be physically of great benefit to officers and men, especially to those in northern garrisons where a long winter compels comparative inactivity for an extended season.

For this annual field service, coast artillery companies should be temporarily organized into battalions and regiments, with the necessary assignments of field and staff officers.

This field service would of course necessitate the total neglect of all coast artillery duties by the companies engaging therein during the time the maneuvers were in progress. For this reason the maneuver period and the annual service practices should be mutually so arranged that no company would be required to fire its service practice after returning from the maneuvers without an adequate length of time to prepare for the practice.

During the maneuvers a small detachment should remain behind for the guard and police of each garrison post, or perhaps better, about half the companies in a district would go at a time, the coast artillery thus attending the maneuvers each summer in two or more installments.

As the question of which or how many companies would be used as either siege artillery or infantry in time of war, is a wholly problematical one, no peace-time organization or assignments to organizations can profitably be made to specifically provide for such service. The present coast artillery organization, with the temporary modifications indicated for instructional purposes, is complete, elastic and satisfactory.

SUMMARY

1. Conditions may arise to warrant or demand the withdrawal of coast artillery troops for field service, for which they must be prepared.

2. The solution of the problem is not identical for the elements,—supports, reserves, and the regular corps.

3. Supports would retain their organization and perform the same kind of duties. As not yet organized, to provide for their withdrawal is impracticable.

4. Reserves should revert to field service as infantry, and their training and peace-time organization should provide for such service.

5. The Coast Artillery Corps might be needed and could be trained either as siege artillery or infantry.

6. A siege battery equipment should be stationed in each of certain artillery districts, and used for instruction and target practice by the companies stationed therein.

7. Infantry training should be given by elaborating the present infantry instruction, and sending coast artillery companies to annual maneuver camps with the mobile army.

8. For all these purposes, the present organization is ample.

THE RECRUITMENT OF OFFICERS

By 1st Lieutenant THOMAS MARSHALL SPAULDING,
Coast Artillery Corps

Of the matters which relate to the efficiency of any army, few are of more vital importance than the recruitment of its officers; and yet, strangely enough, few have hitherto received so little attention in our service. Whatever other professional affairs one may hear discussed among officers, rarely does he hear any mention of this, and still more rarely the expression of any opinion which appears to be founded upon the slightest amount of careful reflection. The most trivial subjects are treated with more serious consideration than this matter of essential importance. No doubt this is in part due to the vague notion that officers seem to share with—or to borrow from—civilians: That the army will ordinarily be officered by the annual graduates of West Point, and that, accordingly, the matter is one that need engage the attention of none but the academic board of that institution. It is hard to see why this should be so. Even supposing that the army were to be entirely or mainly officered from West Point, it would seem that all should be at least as much interested in the character of the material obtained from that source, as in that of the last batch of recruits received from the depot. Moreover, none of us can be ignorant of these facts: That a minority of the officers of the army are graduates of West Point, that a large number is annually commissioned from other sources, and that there is not the slightest prospect that this state of affairs will be changed at any time in the near future, if ever. Whether or not it is desirable that West Point should furnish only its present proportion of each year's appointees, is outside the scope of the present paper. The writer's personal opinion is that the best interests of the service demand the annual appointment of a large number of candidates—university or college men - direct from civil life. However, this need not be here discussed. "It is a condition that confronts us, not a theory."

When the army at large manifests not the slightest interest in the problem of the recruitment of officers, it is natural that little study should be given to the matter, and that the regulations governing the subject should reflect the general indifference. Our line officers have been obtained by a haphazard system,—or, rather, by no system at all. If the material that we have secured has been good, in the main, it has been due more to good luck than to wise planning. Until the publication of the orders now in force (G. O. 79 and 86, W.D., 1909), governing appointments in the coast artillery, the standard of education required of candidates for commissions was deplorably low; and it remains so, as far as the so-called "mobile army" is concerned. Furthermore no adequate effort has ever been made to secure a keen competition for places, even with these low educational requirements. Be the standard what it may, a large body of competitors will insure a higher grade of ability among the appointees than can be had when the number of those who are successful in passing the examinations, by however narrow a margin, does not exceed the number of vacancies to be filled.

So much for present conditions. Now let us consider what may be done by the War Department toward their improvement.

To begin with, the writer desires to suggest a policy which many may deride as visionary, and which may, indeed, be impracticable for the present, but surely not for long. Why not secure for the corps of officers the highest degree of education and mental training that can be exacted of candidates without reducing the supply below the amount required to maintain active competition for the places? In a very brief time, we should be able to limit appointments from civil life to graduates of reputable colleges or of technical schools of collegiate grade. Why should we accept a lower degree of education than is expected in other professions?

Some may object that many young men are unable to secure a college education; but for these there will remain two ways of securing a commission, if they are mentally capable of taking advantage of them,—by graduation from the Military Academy, or by appointment from the ranks; if they are mentally deficient, no one will contend that they are wanted in the army. Again, some will say that we cannot get candidates enough if we set the standard so high. This sounds plausible, but—have we ever tried? Has any appreciable effort ever been made to reach the college man,—or any other man, for that matter,—and to let him know that there is such a thing as the United States Army, and that it is possible to enter it in any other way than through a recruiting office? I assert with the strongest emphasis that sufficient candidates fulfilling the requirements mentioned could be secured without the slightest difficulty, provided only that the proper measures were taken. Of this more will be said hereafter.

At present, however, it may not be considered advisable to adopt this ruling. First let the present standards be raised, and then, if there is still no difficulty in securing qualified candidates, further steps may be considered. Now let us see what may be done immediately toward increasing the quantity and improving the quality of the material from which we have to choose.

THE MILITARY ACADEMY

The adoption of measures tending to raise the standard of admission to the Military Academy, and to fill the vacancies in the corps of cadets, must in the main depend upon the action of the academic board, and is therefore not a subject for discussion in the present paper. In one way, however, assistance may be rendered by the War Department through the office having charge of the recruitment of officers, of which mention will be made later in this paper. Among the duties of this office should be that of giving publicity to the methods of appointment to the Academy, to the requirements for admission, and to the advantages of the training there offered. Circulars should be prepared and widely distributed; in this distribution it would be well to secure the co-operation of the departments of education of the several states, in order that the field should be properly covered. Additional circulars should be sent to the principal high and preparatory schools in each congressional district, a year before a vacancy is expected to occur there. It is unlikely that the standards of admission at West Point will be raised until the corps of cadets has been filled to its authorized strength under the present regulations; but the service just mentioned should alone be nearly sufficient to accomplish this, and it will be time enough then to look for further action.

APPOINTMENTS FROM THE ARMY

The examination of the candidate from the army covers the same ground as that of the candidate from civil life; the increase in requirements should apply to both alike. The soldier will still have a material advantage over the civilian in the preference given to him in the matter of appointment and in his seniority to civilians appointed during the same fiscal year. In one respect, however, it would appear that the present system might well be modified. There seems to be no good reason why the soldier should be required to undergo two examinations in the same subjects,—one before his departmental board, and one at Fort Leavenworth or Fort Monroe. Let a large number of posts be designated annually, at which candidates, whether from the ranks or from civil life, may appear for examination; those from the ranks may be sent to the places nearest their proper stations, thus saving travel expenses. Impartiality in grading may be had by causing all papers to be sent to a single board for marking.

APPOINTMENTS ALLOTTED TO PRIVATE MILITARY SCHOOLS

Existing regulations permit the appointment each year of one honor graduate of each of the ten military schools which have been ranked that year as "distinguished institutions," on account of the grade of military instruction given by them. These honor graduates are admitted without examination, except for the coast artillery, and take rank over the other civilian appointees of that year. It may be well to encourage military training in schools and colleges by the award of commissions to graduates of those which have the best standing in this branch of work, but this award should be sufficient in itself, without exemption from examination in addition. The amount of military instruction given in any school, even West Point, is of trifling importance as compared with the degree of education and mental training possessed by the candidate, and yet the present system sets the graduate of an academy of merely high school grade above the university graduate or the trained engineer, for the sole reason that the former has some slight knowledge of military drill. At the very most, exemption from examination should be granted only to graduates of institutions of collegiate grade; these might be assigned relative rank among themselves by lot, and be followed, first, by the other honor graduates of military schools who have passed the regular examination, and then by the other civilian appointees.

OTHER APPOINTMENTS IN THE LINE OF THE ARMY

Some reference has already been made to the orders now governing appointments to the Coast Artillery Corps. These prescribe an educational standard much superior to that previously exacted for any arm of the service, and to that still fixed for the mobile army. At the same time they embody a new system of examinations which is admirably calculated to test the education of the candidate, and at the same time avoids the necessity of useless drudgery in marking a large mass of papers. The examination is divided into two parts, of which the first or elementary portion is not required of the college graduate. If this were taken by all candidates, the university man would be placed at a positive disadvantage, for he would probably be outranked by a high-school boy in such subjects as grammar, geography, and algebra, which are fresh in the latter's mind. Certainly the more highly educated man should not be discriminated against.

Let this separation of the examination into two parts be adopted for all arms of the service, the college graduates to be excused from the elementary portion. This includes, in the present regulations for the coast artillery: Grammar, geography, history, algebra, plane and solid geometry, plane and spherical trigonometry, and the elements of calculus. This is a reasonable amount of work to place in the elementary section; the exact requirements might be modified as deemed advisable.

There remains to be considered the second section of the examination, which is to be required of all candidates, and is to determine the relative rank of the successful competitors. The present regulations for the mobile army demand, in addition to the subjects above mentioned, only the following:—Elements of surveying; elements of constitutional and international law; army regulations; and drill regulations of either infantry, cavalry, or field artillery, as elected by the candidate. (Of the preliminary examination subjects named above, calculus is not in the requirements for the mobile army.) These requirements are faulty in two respects. In the first place, they are inadequate; the *amount* of the work implied—I do not say the exact scope—is rather less than that given by the end of the freshman year of college. In the second place, the military subjects demanded effectually exclude the immense majority of college men, and all for the sake of securing candidates who are able to drill a platoon.

It seems reasonable that the second section of the examination should call for much more extended preparation than that just mentioned, and that these elementary military subjects should no longer be essential. Furthermore, it is inexpedient that the requirements should be absolutely rigid. Is a knowledge of international law of any more importance to a second lieutenant than a knowledge of German, or ability to use a transit of more value than acquaintance with electrical instruments?

To broaden the field of the examination as far as possible, let the candidate be required simply to secure a certain number of units of credit, in subjects selected by himself from the list offered. A subject may be valued at one or more units of credit, according to its importance or the amount of study that its mastery may be supposed to require. The number of credits required should be perhaps twice what could be earned in the subjects now required for the mobile army. The list of subjects should be varied, and fairly large, but must be kept within reasonable limits in order to avoid the labor of preparing a great number of different examination papers.

Several subjects are suggested below; these probably offer a wide enough field for selection, but others could be added if it were considered worth while. No attempt has been made to fix the number of units of credit attached to each.

Let us begin with the subjects already mentioned as now required for the mobile army:

1. Constitutional law.
2. International law.
3. Surveying.
4. Army Regulations.
5. Drill Regulations,—infantry, cavalry, field artillery, or coast artillery.

Constitutional and international law are here classed as two separate subjects; under this elective system there is no reason why the candidate should lose the credit he might earn in one, because he has never studied the other. The military subjects are retained for the benefit of candidates from the ranks and of those who have attended military schools. Coast Artillery Drill Regulations has been added to the list of options under count 5.

Next should be included the subjects now required in the coast artillery examination:

6. Elementary mechanics.
7. Elementary electricity.
8. Elementary chemistry.
9. Advanced mathematics, including analytical geometry and differential and integral calculus.
10. Advanced electricity (elements of electrical engineering).

11. Advanced mechanics, including steam engines and boilers and gas engines.

Subject 9 might well be broken into two parts, as was done with the law subjects.

In extending this list it will be generally agreed, no doubt, that modern languages should be the first subjects to be added. We therefore include:

12. French.
13. German.
14. Spanish.

The examinations in these subjects should be so planned as to test the candidate's actual ability to read and write the language selected; they should not consist of a series of grammatical puzzles. It might be well to require that credits should be earned in only one or two of the language subjects.

One other subject is suggested, to complete the list:

15. Elementary law.

Probably few things that can be studied in school or college are of more practical value to officers of all arms than this; it seems unnecessary to detail reasons for including it here.

To insure the special preparation desired for officers of the coast artillery, it should be ordered that to be eligible for appointment in that branch, the candidate must earn a certain proportion of his credits in the technical subjects,—numbers 3, 6, 7, 8, 9, 10 and 11.

METHOD OF EXAMINATION

This scheme contemplates the merging into one, of the examinations of all candidates for appointment from the ranks or from civil life, whether for the coast artillery, or the mobile army. A large number of posts should be named, at which candidates should be directed to report. Each candidate must designate in advance the subjects in which he desires to be examined, and only the number of papers required in each subject need be sent to any particular post. At the close of the examination, all papers in any one subject should be sent to a single board for marking.

OFFICERS OF THE STAFF CORPS

An act passed at the last session of Congress authorizes the appointment of engineer officers from among graduates of engineering schools. At the time this is written, no details regarding the system of examination have been announced.

Necessarily, the examinations will be professional and technical, and candidates for the Corps of Engineers cannot be examined under the scheme outlined above. It is suggested, however, that these examinations be held at the same time as those for the line, that candidates for the engineers be graded according to their marks on the same list as the others, and that those who succeed in passing, but for whom vacancies do not remain in the engineers, be entitled to appointment elsewhere if their standing is high enough. Some plan of grading could be arranged which would be fair to all concerned.

The Medical Corps has already a system which should secure a very high average of professional ability in those accepted for appointment in it. Its examinations must necessarily be separate from those for the rest of the army.

Nothing more need be said here concerning officers of the staff corps, except that the task of securing candidates for them all, as well as for the line, should be in the hands of one office,—of what I should call the advertising department, except that for some inscrutable reason many officers seem to find the expression obnoxious; let us call it the publicity bureau.

THE SECURING OF CANDIDATES

Whatever qualifications may be exacted of candidates for commissions, the securing of a large number of competitors is of the highest importance. In this respect, even more than as regards the educational standard set, is the present system deficient. Our officers are generally secured by pure accident; of the class of young men who would be of most service to us, there is not one out of a hundred who has ever heard of the possibility of entering the army as an officer. The student may consider a dozen occupations, but the notion of entering the military profession never crosses his mind. Yet a very slight amount of effort, properly applied, would cause commissions to be eagerly sought by many times the number of candidates that could be received. If at any time there are not enough applicants to fill existing vacancies, then it is imperative that more should be had; if there are more applicants than enough, then the stronger the competition can be made, the better will be the quality of the material actually accepted. At all times, then, it is important to attract as many competitors as possible.

To secure a great number of candidates,—and candidates of excellent education,—it is necessary to do only one thing, and that a very easy one; namely, to let the public know that places are open in the army, and that college men are wanted for them. This statement is not based on guesswork; the writer *knows* that what he says is true. He has himself tried an unofficial experiment in the kind of work he suggests; this was done in a very small way, and with a single university, but the results have been such as should satisfy anyone of the correctness of the opinions here expressed.

The duty of securing candidates for appointment in all branches of the service, both line and staff, and also for appointment as cadets at the United States Military Academy, should be placed in the hands of a single office at the War Department. It is imperative that this office should be controlled by a man somewhat familiar with the educational system of the country, and heartily interested in the work. Circulars should be prepared setting forth the information that should be given regarding the scope of the examinations, and the advantages and disadvantages of the military profession. The general orders occasionally issued by the War Department are not sufficient. It must be remembered that the American public generally is absolutely ignorant of everything pertaining to its army, and the operations of this office must be governed accordingly. The necessary circulars should be sent to all large institutions of collegiate rank, and to the leading military preparatory schools. Efforts should be made to enlist the interest and co-operation of the governing and teaching bodies of these institutions. The officer in charge of the bureau should be ready to supply promptly, both by printed circulars and by personal letters, all information called for. The expense involved in the work of this office would be insignificant,—a few dollars, no more; the benefit it could effect would be incalculable. Important as is the matter of raising the standard of qualification, it is of less consequence than is the establishment of the service here outlined.

CONCLUSION

No attempt has been made in this paper to specify the details of the recruiting system here recommended; such an attempt would be useless in advance of the adoption of the general features of the plan. The whole subject has been so generally neglected that no radical improvement in conditions can be expected until enough interest can be aroused in the service to demand for the matter the consideration it deserves. It is hoped that this paper may aid in some slight degree in turning the attention of officers toward our needs, our shortcomings, and our opportunities.

ANALYSIS OF TARGET PRACTICE REPORTS

BY MAJOR GEORGE F. LANDERS, COAST ARTILLERY CORPS

Some time ago in a general discussion a coast artillery officer made a statement to the effect that coast artillery target practice was improving, but that officers failed to a remarkable degree in obtaining the full benefits from the various appliances that are provided, and, in many cases, the various devices found in the range station were not used properly, and again, after the firing was over the reports were submitted and no careful study and analysis of the results ever made.

Every individual will no doubt as emphatically repudiate this as applying to himself as those who were present did.

Called upon to specify in particular just what he meant the officer enumerated the following:—

1. Target reports made out incorrectly, inaccurately and giving false information.
2. Range boards, wind component indicators, deflection boards and the powder velocity curves used incorrectly.
3. Failure to take advantage of the results of the trial shots.
4. Failure to study the behavior of the guns in the battery.
5. Blaming material, where the personnel is wholly responsible.

The next requirement made of this officer was: Prove your statement.

All the target reports available, about twenty in number, were secured and with range board, deflection board, wind component indicator and powder velocity curve comfortably installed in a large room, the dissection and analysis began. This work continued for weeks and the result was astonishing. Eighty per cent. of the reports were unanimously declared to be defective and properly subject to one or more of the criticisms enumerated above. The result of this work, however, was so very instructive and interesting that it was felt that it if it could be properly placed before others a similar interest and enthusiasm might be aroused.

The following reports are selected and discussed very briefly along the lines followed.

FIRST EXAMPLE

In the fall of 1909 a company on two successive days held its target practice at a 12-inch battery. The powder used in the two practices had all been blended together.

The following is taken directly from the reports.

FIRST DAY.

	No. of Shot.	Tactic'l No. Piece.	Actual Range	Correct'd Range.	Struck Short — Over +	M. V. Assum'd.	Temp. Charge.	Temp. of Air.
Trial Shots.	1	1	5990	6535	+ 12	2140	58° F	56° F
	2	1	5990	6535	+ 216	2140	58° F	56° F
	3	1	5990	6550	+ 16	2140	58° F	56° F
Record Shots.	1	2	5320	5820	— 21	Record shots only. M. V. assumed 2140 f.s. Temperature of Air 56° F. Correction in range for 1st record shot as result of trial shots 0 yards.		
	2	1	5320	5820	+ 147			
	3	2	5165	5665	— 35			
	4	2	5130	5630	+ 20			
	5	1	5070	5570	+ 48			
	6	1	5030	5530	+ 98			

SECOND DAY.

Trial Shots.	1	2	6020	6540	+ 100	2140	68° F	71° F
	2	2	6020	6540	— 139	2140	68° F	71° F
	3	2	6020	6540	+ 280	2140	68° F	71° F
Record Shots.	1	2	7363	7880	+ 53	M. V. assumed 2140 f.s. Temperature of Air 71° F. Correction in range for 1st record shot as result of trial shots 0 yards.		
	2	2	7358	7980	+ 125			
	3	1	7385	7915	+ 103			
	4	1	7320	7860	+ 136			

FIRST DAY'S FIRING

Not open to much criticism. The second trial shot appears to have been thrown out in determining the muzzle velocity for the record shooting. If it had been considered, the mean over would be 81 yards, making M.V. for record shots 2157, which would have given 70 yards less for each corrected range. With this decreased corrected range, overs and shorts would have been:

No. 1 Gun.	No. 2 Gun.
+77	—91
—22	—105
+28	—50

The record shots from the gun that fired the trial shots would most probably have been all hits for range.

Whether the second trial shot should have been considered or not is a question that the battery commander decides, but why should it not be considered when the gun for that shot was laid with as much care as for the others?

In this record shooting the guns shot with respect to the target:

No. 1 Gun.	No. 2 Gun.
+147	—21
+48	—35
+98	+20
3) +293	3)—36
+98	—12

Conclusion: No. 1 gun shooting 110 yards stronger than No. 2 gun at a range of 5700 yards.

SECOND DAY'S FIRING

No. 2 gun fires the trial shots.

The center of impact is 80 yards over. Is this logical? Should we have expected this? No. 1 gun shot 81 yards over the day before and we saw from the above conclusion that we ought to expect No. 2 gun to shoot about 110 yards short of No. 1, whereas today No. 2 is shooting up to the range of No. 1's shooting of yesterday. What is the trouble? Look at the temperature of the powder, 10 degrees greater than the 1st day. This ten degrees means an increase of 18 f.s. in M.V., which means an increased range of 80 yards.

We conclude then that at the range of the trial shots No. 2 gun is consistent with its work of the day before and we can proceed with confidence.

The target report shows that the M.V. for the record shots was taken as 2140, but was it, as a matter-of-fact taken as 2140?

The 80 yards over of the trial shots corresponds to a M.V. of 2157. Going to our range board we find positively that shots 1, 3 and 4 were laid to a corrected range corresponding to 2157 M.V. and that only No. 2 shot was fired with 2140 M.V.

At 7900 yards a difference in M.V. of 17 f.s. means a difference in range of 90 yards. Had the 2nd record shot been laid for 2157 f.s. it would have gone only 35 yards over, or the overs would have been:

No. 2 Gun.	No. 1 Gun.
+53	+103
+35	+134
2) +88	2) +237
+44	+119

Again the gun firing the trial shots would have made all hits, and again did No. 1 gun shoot 75 yards stronger than No. 2 gun.

Would it not be safe to treat this firing the same as calibration firing and with No. 2 gun set at 5700 yards move the pointer to read only 5590 yards, or when set for 7900 yards move the pointer to indicate 7825 yards?

Are the above facts worth considering or not? Is there anything there that a competent range officer should not see at a glance, and should it take a battery commander longer than five minutes after he receives the result of his trial shots before he is ready for his record shooting?

To accompany the above method of studying Target Practice Reports the following method of drill has been found to be valuable:

After the men are familiar with the manual of the piece, simulate target practice. Get a number of target reports, preferably those in which the shooting has been good; send to your range officer the M.V. and the actual range to the target as used in firing the trial shots.

The range officer prepares and sends gun data for the trial shots. After each trial shot send to the range station the over or short as shown on the target report, and continue until the trial shots have been fired. Now then determine the M.V. to be used for the record shots, compare your M.V. with that used in the target report and study which would have given better results.

A most accurate comparison can be made between your hypothetical shooting and the actual shooting as given on the target report. This method of drilling has been used for some time, the Fire Commander giving the data and always absolutely conforming to the data as shown in the target reports. If sufficient target reports are available all conceivable conditions will present themselves.

This drill when followed out earnestly and conscientiously is the most valuable target practice drill that you can have. Why? Because you can tell by comparison with the target practice report just what your range detail is capable of doing, and where your shots are falling.

If "visiting companies" were required to keep a copy of Form 821 with their target reports they would then have all the data at hand for checking up corrected ranges and deflections and the above drill would be more satisfactory.

If Coast Artillery Memorandum No. 8 contained full data from selected target reports it would be of great value in making a study of the shooting. The present listed data in the Memorandum referred to is incomplete, unsatisfactory and unreliable, for the reason, as stated in the first part of this paper, that many target reports are made out incorrectly, inaccurately and give false information.

SECOND EXAMPLE

The data on page 276 is taken from two target reports of a 12-inch battery. The firing was done in the summer and fall of 1910.

FIRST DAY'S FIRING

The first thing that strikes us is the fact that the first trial shot is fired by increasing the range 1000 yards. No M.V. is assumed and this shot appears to have been fired simply to get a line on the powder. Could this information have been gotten in any other way? On page 38 of Coast Artillery Memorandum No. 6, 1909, we find the same lot of powder was fired from a 12-inch battery in 1908. It is not surprising that anyone would balk in deducing information from this, however, for it is seen that at the first practice a M.V. for trial shots of 2220 was assumed, and as a result of the trial shots the M.V. was reduced to 2140, but for the record shooting the mean remained 300 yards short, showing that the powder was much weaker than 2140 f.s. The approximate amount can not be determined as there are no ranges given for the record shooting. A few months later with

FIRST DAY.

	No. of Shot.	No. of Gun.	Range Board Ref. Nos.				Range Cor'tion Scale.	Actual Range.	Corrected Range.	Tug to Target.	Range Errors.			
			Tide.	Atmos.	Wind.	M. V.					Mils from Tug.	Yards by Rake.	Plotted.	Camera.
Trial Shots.	1	1	1.1	17	42	Off Scale	3000	5880	6880	290	3000	+ 870	+715	
	2	1	1.1	17	42	2140	2500	5880	6380	290	660	+ 191	+150	
	3	1	1.1	17	42	2140	2500	5880	6380	290	660	+ 191	+160	
Record Shots.	1	1	.8	17	42	2170	2365	5685	6050	220	233	+ 51		+37
	2	2	.8	17	42	2170	2365	5645	6010	220	380	+ 83		+66
	3	1	.8	17	42	2170	2365	5635	6000	220	150	+ 33		+26
	4	2	.8	17	42	2170	2365	5610	5975	220	65	+ 14		+10

Temperature of Powder 60° F.
Kind of Powder: du Pont, Lot No. 2, 1901. Nitro-cellulose.
Correction for 1st Record Shot as result of Trial Shots 365 yards.

SECOND DAY.

Trial Shots.	1	1	.8	19	63	2180	2295	7940	8240	220	900	+ 194	+180	
	2	1	.6	19	63	2180	2295	7940	8240	220	400	+ 129	+120	
	3	1	.6	19	63	2180	2295	7940	8240	220	200	+ 64	+ 60	
Record Shots.	1	2	.5	19.5	58	2209	2120	8205	8325	216	20	— 4		— 4
	2	1	.5	19.5	58	2209	2120	8205	8325	216	650	—140		
	3	2	.5	19.5	58	2209	2120	8190	8310	216	50	+ 11		
	4	1	.5	19.5	58	2209	2120	8170	8290	216	80	— 17		—15
	5	2	.5	19.5	58	2209	2120	8150	8270	216	350	— 77		
	6	1	.5	19.5	58	2209	2120	8150	8270	216	170	— 37		—37

Temperature of Powder 71° F.
Kind of Powder: du Pont, Lot No. 2, 1901.
Correction for 1st Record Shot as result of Trial Shots + 120 yards.

a loss of about 24 f.s. due to decrease in temperature of the charge the assumed M.V. for trial and record shots is taken as 2214 and the mean of the record shots is —10. Anyone looking for information would be badly confused. In any event in the shooting under discussion this first trial shot was given a corrected range of 6880 to reach a target whose range was 5880. What was the M.V. assumed for this shot? The report says "off scale." Yes, it was off the scale, but it is a simple matter to quickly determine that the M.V. assumed was 2050, and correcting for 715 yards over would give us a M.V. of 2195 as the result of the first shot. Use the range board and see what you get for yourself. Using the data on the target report, would not 6405 be a more accurate setting than 6380 for the second and third trial shots? If the second and third shots had been fired at a setting of 6405 yards the overs would have been 175 and 185. Our M.V. then for our record shots would have been 2178 instead of 2170. In firing the record shots the Range Correction Scale was set each time at 2365. This is what the target report data makes it providing the target were stationary and we were figuring to hit at the water line instead of half the danger space beyond the target. Therefore, 2170 instead of 2178 f.s. M.V. was used and no allowance was made for height of target; in this particular case the effect of one is negative and the other positive, hence, the error is minimized.

The correct gun arm setting for a stationary target, using 2178 M.V. and increasing the range for half the danger space would have been 2385. Considering the four hits for range as shown by the camera overs, no fault can be found; on the other hand by using the data correctly the center of impact would have been 55 yards over as against the 35 over as shown by the report. Which is the better result? Which comes nearer to being half the danger space over the target, and which is preferable, looking at it from the requirements of modern artillery?

SECOND DAY'S FIRING

Naturally the first question is: What will be the M.V. for our trial shots? The battery commander took 2180. At his preceding practice he used 2170 at 60°F. The powder is now at a temperature of 71°F. Why not go to powder velocity curve and determine that it should give at this new temperature 20 f.s. greater velocity than at 60°F. and correct accordingly?

Why is the value of 1 Mil for the first trial shot .21$\frac{5}{9}$ yards and for the second and third .32 yards?

To determine the M.V. for the record shots the battery commander corrected for 120 yards over. It requires a correction for 165 yards to give the new velocity of 2209. Whereas a correction for 120 yards gives a velocity of 2201. Where did the 165 yards come from?

At the range at which the record shots were fired, using 2209 instead of 2201, caused the corrected range to be decreased 40 yards.

Again, the record shots were laid to hit the water line of the target and not to hit at half the danger space beyond the target.

The center of impact of the record shots is —44 yards. By using a M.V. of 2201 instead of 2209 the center of impact would have been at —4 yards.

IT PAYS TO ADVERTISE

BY "HELM"

"Not one good American in five hundred could tell you a "corporal from a captain; not one in five thousand a corporal "from a sergeant. Red, white, yellow and green stripes in the "army are simply mere personal dandyisms of the wearer and "have nothing to do with whether he shall fight on four legs, "on two, or none at all. The best place for an orderly to carry "his sword,—answer quickly: Does an orderly carry a sword?— "is in the top of his left boot where he can fall over it as he exits "from testifying at the court-martial. - - - - - - This "court-martial, of course, arose from a scandal. The scandal "occurred at a post. We all read the newspapers and we all "know that such scandals are about all that occur at posts; "according to our newspaper information and our playwrights "almost all the officers are drunkards, murderers and liars— "except the hero—and the bulk of the American army is made "up of bums and comic old Irishmen."

("Plays and Players" column, *Hampton's Magazine*, December, 1910.)

"The uniform can be raised in the respect of the American "people by safeguarding it from the acts of our poorest men. "Offenses committed in uniform should be considered as of an "aggravated nature and more severely punished than under "other circumstances. Regulate the wearing of the uniform "outside garrison limits by permitting only excellent soldiers "to wear it, and public opinion will soon be more favorable "toward it and toward the soldier."

("Character Excellent," Capt. F. J. Morrow, 12th Infantry, *Infantry Journal*, September, 1910.)

In the above quotation from *Hampton's*, which could be paralleled in a hundred instances by examination of the public prints of the last six months, may be read a large part of the answer to that oft reiterated question, "What's the matter with the Army?" In the caption of this article, "It pays to Advertise," is the suggestion which, if followed, would go a long way toward curing the unfortunate condition which now exists. In the quotation from Captain Morrow's article is found the bare skeleton of a method whereby he expects,—it would seem with good reason,—to benefit the condition of excellent soldiers by improving their status in the estimation of the civilian communities near which they are stationed, but which, if carried out consistently and logically in all its details and ramifications, would affect favorably not alone individual soldiers, but the Army as a whole, by keeping it continually before the public in its best and most attractive guise. In other words, it would be a most valuable and paying advertisement for the Army.

Let us examine briefly this question of advertising. Is the statement "It pays to advertise" a mere catch-word of the newspapers and magazines contrived to bring in to them those weekly acres of advertising matter at high rates? Hardly, considering that the principle was enjoined and utilized long before news sheets were thought of. The Greek bards extolled the various oracles, deliberately or unconsciously attracting additional thousands to the prophetic altars. On the walls of exhumed Pompeii we may read still "I vote for Marcus Quintus for aedile. He is a friend of the wine-sellers," or words to similar purport. I may also quote without irreverance of thought "Let your light so shine before men, etc." As for the present day, unless the American people as a class are fools in business matters, which few or none will maintain, the amount of annual expenditure for advertising, comparable in magnitude to the total appropriation for the Army and Navy, is sufficient testimony that "It pays," and that the statement under discussion may be accepted as an axiom.

Is advertising unnecessary to the Army? Read over again the whimsical but perfectly true description of the state of civilian knowledge of the army which I have quoted from *Hampton's*. Can you expect an intelligent man to advocate appropriations for anything which is to him little more than an abstract theory, often contested? Such is the Army to the average voter.

Is it undignified for the Army to advertise? Let us omit consideration of all business or commercial advertising, lest some one might protest that the Army is not a business, but a profession. Let us examine the custom of the professions of medicine, the law, the ministry. Let us leave out also, if you will, the newspaper and magazine "puffs" that admiring friends spontaneously (?) supply in such liberal quantities, the full data and details for which are always so reluctantly (?) supplied by the subjects.

Professional etiquette, any member of these professions will state, forbids him to advertise. However, nearly every method short of paid-for space in the public prints which may bring these professional men before the public view in a favorable light is persistently employed. The young doctor starves himself for the best possible clothes, offices, and an automobile; the young lawyer omits the automobile to show himself in the precincts of important courts, always with many legal papers, (or his lunch), in the professional green bag, and as often as possible in conversation with the seniors of his profession or other noted or conspicuous men; the clergy advertise openly, but by proxy, using each his church as his proxy before the public.

All professions, in addition, write, write, write, and speak, speak, speak, for publication or in public, taking care to avoid the third person or the editorial "we."

Are any of these or similar practices wrong, unnecessary, when properly indulged in or undignified? Is it undignified for the Army to try to put and keep itself before the voting public that sustains, or ought to sustain, it, in its best clothes, its characteristic and identifying uniform, and taking pains that the average behavior of those so identified shall be at least as high as that which is demanded at an army post?

Many influences are now at work, some of very recent birth, which tend to bring the Army before the public as a concrete proposition. These we must aid and supplement, for there is a world of misapprehension and much hostility for them to combat. It must be remembered that war, battle, arms and armies have been held as unnecessary in the minds of Utopian dreamers since the opening of the Christian era. Persistent effort on the part of these good but unpractical millenium-chasers, meeting of late with but little resistance, has resulted in the degradation of the regular soldier,—considered as an abstract proposition,—to a licensed "murderer," "ignorant hireling butcher," or other more or less forcible but always uncomplimentary classification, in the minds of a great majority of the citizens of the United States. Occasionally a war has obliterated the abstract picture and shown the concrete value of the regular soldier, but the press notices of the volunteer heroes who fought and died, or only plain died through neglect and ignorance, have for the most part obscured the fact of duty efficiently performed at small cost of life by the few regular organizations. Once or twice national calamities such as the San Francisco earthquake or the recent forest fires have shown the citizens of certain localities that the regular soldier is a man to be admired, and the Army something more than, for example, "an instrument for the oppression of our colonial wards." But a few months suffice to throw the impression of these services into the background, and the false abstraction again prevails; the regular soldier is again the "hireling oppressor," and the "licensed murderer."

The fault lies with the Army itself. Recruiting officers may advertise with glowing lithographs, carefully omitting the pick and shovel; their picture is not accepted, because they are in the position of wanting something from the people, and they are naturally imagined to show all the good points and none of the disadvantages of what they have to offer. Moreover, their influence is pitifully local, in comparison with the number of people to be influenced. Public prints, newspapers and magazines, speak glowingly of the efficiency of the Army, or earnestly of its needs, which good work is immediately offset by other articles decrying the need of any army, or vilifying the system and personnel. The people influenced by any such articles are, again, few, and the net result is publicity indeed, but publicity of confusion of idea only. The National Guard, so far, has done more for the popularization of the regular army than any other influence. Its influence has been strong, united, and along the most helpful lines. Here again, however, we come into contact with only a limited portion of the population.

All these influences, of whatever character, are, moreover, working on the abstract ideal of the soldier, though through the influence of the Guard we have obtained very concrete benefits.

Outside of the recruiting service, the influence of which has been touched upon, and excepting the great and valuable influence exerted through the presence of regular organizations at a few large fairs, carnivals, and tournaments, the Army itself has done nothing to bring itself before the people, to advertise.

Everything remains to be done in this line. The abstract idea of the Army and of individual soldiers so long and sedulously cultivated by peace-faddists is almost uncontested in the minds of the great majority of American citizens. Why should it be otherwise? Not one American in a thousand but has to go out of his way to see a soldier in uniform, and there is no reason in his mind why he should go. The resulting ignorance is a thing which the Army itself can and should combat.

What should be done? Captain Morrow almost answered this question, but was looking at his proposition from another point of view, and missed noting the greatest value of the policy he was outlining in the paragraph quoted above. What is done in the service is done in accordance with orders. Let us draft a tentative order and then consider its value and effects. The lowest commanders who could effect appreciable results in this way would be post commanders in the mobile army and artillery district commanders in the coast artillery.

GENERAL ORDERS,
 No.....

Par. 1. From date the following rules will govern the wearing of uniform or civilian clothing by the enlisted men of this command while on pass:

a. No man shall leave the post in uniform unless specific permission to do so is endorsed on his pass.

b. Organization commanders are given entire discretion in the matter of the above permission, and will therefore be held strictly responsible by the Commanding Officer in case any man of their respective organizations, while on pass in uniform, reflect the slightest discredit on the service by their actions or appearance.

c. A careful inspection of appearance of men going on and returning from pass will be made by organization commanders, or subordinate officers designated by them, as well as by the Sergeant of the Guard. No man without a clean, well-fitting uniform, or under the influence of liquor, will be allowed to leave the post on a "uniform" pass. Reports to the Officer of the Day and to organization commanders will be made by their respective subordinates of every case where a man's appearance and condition is not entirely creditable on his return from pass.

d. Any man who misconducts himself in uniform while on pass, or returns on a "uniform" pass intoxicated, or with uniform dirty or disarranged, will, in addition to any company discipline or summary court sentence imposed, be denied the privilege of going on pass in uniform for a period of three months from date of the offense.

Par. 2. A memorandum will be published from time to time giving a list of theatres, restaurants, etc., in .... (the neighboring town or towns) which, having received copies of this order, desire the custom of the uniformed enlisted men of this command, and guarantee that no distinction in courtesy or accommodation will be made between them and the best favored patrons.

Par. 3. Strict compliance with the above provisions is required, and the hearty cooperation of the officers and men of this command is expected to further carry out the object of this order, which is to restore a relationship of mutual respect between the citizens of the neighboring towns and the soldiers of this command by showing that a soldier in the uniform of the United States is to be normally expected to be a good citizen as well, worthy of respect and friendship of other good citizens, and one from whom man, woman or child will always receive courtesy, and assistance or protection in case of necessity.

To determine the effect of such an order as the above, we must examine the present conditions, which have led to the uniform, and hence the soldiers as a class, falling into disrepute. The original cause is difficult to determine. It lies probably in the fact that we are not a military nation, and that a soldier off duty, on that account, has never been able to feel that his uniform implied the slightest superiority over the civilians about him. Its individuality moreover rendered him slightly conspicuous in a gathering of civilians. Whatever be that original cause, civilian clothes seem always to have been desirable to the soldier going on pass, and a premium was placed on them for a long time by allowing only the best men to wear them or even possess them. At the present time a good suit of civilian clothes is more prized by a soldier than his best uniform, and his pay is mortgaged to acquire such a suit if by any chance he is without them. It is only the few drunkards and spendthrifts, or men whose many derelictions consume their pay in court-martial sentences that cannot get together the money to acquire a civilian suit. Thus it is a certainty from the start, under present conditions, that a large percentage of the unreliable men of a command will go on pass in uniform. Of these men a large percentage actually misconduct themselves to some extent while off the post, bringing the uniform into disrepute, and making the good, steady men less and less willing to wear the uniform on pass, as it of course would class them with the drunkards and disorderly characters mentioned. In the final outcome, practically the only men in uniform in a city are to be found in the lower classes of resorts, and in some stage of intoxication wherever found.

This is the kind of advertising the Army has been and is now doing.

An order such as has been suggested above would at once prevent ninety per cent. of the delinquents from casting any discredit on the service except among their immediate associates, or occasionally through loud-mouthedness in public. They would be in town, if at all, in civilian clothes, and a drunken civilian in most cities attracts but the slightest attention. We should at once cease to advertise our worst wares; the uniform when seen would be creditably worn, and by our good men, of whom we may always be proud. After this immediate effect, progress would be slower, but none the less certain. Most of those men to whom permission to wear uniform would naturally be granted would still wear their civilian clothes. Curiosity, however, would lead many to test the assurances given by the listed theatres and restaurants; the order suggested would certainly be a fair news item for the dailies, and possibly be much discussed therein, and occasionally a soldier would be asked by his civilian friends why he did not wear uniform; he would wear it on his next trip to town, simply to show that he could get permission. Remembering that a "well fitting" uniform is required by the order, it may be predicted that the men on pass in civilian clothes would never have reason to be other than proud of the uniform as worn by their comrades, whatever might be their opinions as to the desirability of wearing it, while to keep up the civilian outfit would mean semi-annual expenditure to follow the seasons closely and styles even at a distance. Economy and pride would thus combine to bring many men to wear the uniform, which is always good, suited to every season, and never out of style. In the end nearly all men who were so permitted would habitually wear uniform on pass and probably also on furlough.

All this change, which would be accomplished faster or slower according to characteristics of companies or regiments on the one hand and disposition of towns-people on the other, would gradually make the uniform so familiar and so well liked that only the newsboys and bootblacks would pay more attention to its wearers than to civilians. These two classes of enterprising youth will, I believe perennially and eternally "josh" a uniform of any kind whenever amusement can be extracted therefrom. Instances of misconduct on the part of wearers of the uniform would become rarer and rarer, and the percentage of ninety per cent. disorderly would drop to ten per cent., to five per cent., as the unreliable men were weeded out of the preferred list. It is not impossible that within a year even civilians would say "What a shame to disgrace *the* uniform!" (not *his* uniform), instead of "There goes another drunken soldier."

This brings us to the side of the question in which real value to the Army lies, the effect on the attitude of civilians toward the Army as a whole, its problems and needs.

At first the soldiers would be tolerated and watched, then approached, then liked, for the average American soldier has the sterling fundamental qualities which compel liking from those who can be induced to get close enough to know him. The sentiment toward individual soldiers would extend to organizations, to the corps or arm of the service, eventually to the whole Army. Local enlistments of the better class of young men would become more frequent when people began to realize that their particular friend, Sergeant, Corporal or Private, was not the shining exception in his company, troop or battery in the respect of manly virtues. Old, near-sighted ladies would still ask foolish questions of anyone in uniform, but would be able to distinguish a soldier from a conductor or elevator boy. The American people is observant and intelligent; the trouble has been with the Army itself; it has given the people little to observe, and that of its worst. Laws for the protection of the uniform would be enacted in response to popular demand when the wearers of the uniform had made it familiar and shown it to be worthy of protection.

In these and in other multifarious ways we should feel the good results of the advertising that pays.

So far the matter has been discussed from a local point of view, as a situation existing at and near one post or district. There is a broader point of view.

Our national defenses are inadequate in almost every detail. Our Army is so small in proportion to the barest needs of the country as to be ridiculous in the opinion of foreign experts. The Army knows this, and a few far-seeing men in and out of Congress know it and are trying to gain strength to ask for adequate forces. Is it too much for them to ask of the Army itself that it shall familiarize the civilians it can reach with the present conditions, with the uniform, the character of the personnel? That the Army itself should do its part in destroying the bugaboo "Militarism?" By the efforts of the Army authorities alone, millions of voters would become familiar with the Army and its uniform under the best circumstances in twelve months, where now but a small fraction of the voting population has seen the uniform on a regular soldier, and of those few, too many, unfortunately, have seen some of the disgraces. The writer lived within five miles of Boston City Hall between the ages of six and twenty-one, fifteen years, and does not now recall ever during that period, seeing more than but one regular soldier, this too when he was actually in the city itself every school day in the last eight years of that period.

Is it not too much to expect that an ordinary voter should enthusiastically or at all support increased appropriations for a regular army he has never seen, which is hardly mentioned in the history he studied at school, though the United States appeared therein as always conclusively victorious in all its wars, and when if he reads all the ordinary voter reads about the Army, and more, he finds nearly as many articles saying "Abolish" as "Maintain" and almost never one saying "Increase."

Let us do our part in the work for our interests, which are certainly the interests of the United States, and take care that the "ordinary voter" near our posts knows the Army and its soldiers well and favorably. The men can show him the lying statements in the magazine articles; they know what posts and guns lack personnel, and how weak, to the point of absurdity, is our little mobile army; they know in a general way pretty well what the needs of the Army are.

The men will be fifty thousand additional able missionaries if they can be brought in to a relation of mutual respect and liking as soldiers, uniformed regular soldiers, with the civilians in the vicinity of the posts at which they are successively stationed. This condition can be brought about by the Army authorities alone, and without legislation of any sort.

"It Pays to Advertise." Why do we not begin now to advertise, and to advertise our best.

DEFLECTION CORRECTIONS FOR SECONDARY ARMAMENT

BY CAPTAIN ROBERT E. WYLLIE, COAST ARTILLERY CORPS

In the correspondence column of the last issue of the JOURNAL is the description of a device for deflection corrections by gun pointers from observation of splashes. While not specifically stated, it is apparently intended for 3-inch guns.* I am, of course, aware that the Coast Artillery Drill Regulations contemplate that gun pointers shall correct their own deflection errors, but, while this may be feasible at batteries of large caliber, my experience with 3-inch guns indicates that the B. C. should perform that duty. With two guns firing it is difficult, and with more than two guns, impossible, for the B. C. to pick out the splashes of any one gun, and the gun pointer cannot do it even with two guns, as he is not, or should not be, paying attention to any gun but his own, and would naturally take the first splash he saw, which might or might not be his.

The causes of lateral deviations are as follows:

1. The inherent error of the gun and mount.
2. Inaccurate bore sighting.
3. Inaccurate correction by B. C. for travel of target, wind and drift.
4. Inaccurate setting of deflection by the gun pointer.
5. Faulty gun pointing, in that the pointer fires when not on the center of the target. This may be due to one, or both, of two causes,—i, the pointer is rattled; ii, too great a desire for rapidity of fire. In either case the effect is the same, he fires when "Ready" is given, whether on the target or not.

The deviation due to No. 1 at our target practice ranges is extremely small. This will be patent to any one who will observe carefully fired trial shots.

Battery commanders should always bore-sight their guns before firing. Don't assume that the sight is correct but verify with care. This will remedy No. 2.

---

* See Journal U. S. Artillery for March-April, 1911, p. 238. The device described there was intended for guns of the primary armament, but Captain Wyllie's remarks are just as pertinent upon the subject of deflection corrections for guns of the secondary armament.—EDITOR.

If the battery commander has made an incorrect initial deflection, it will apply equally to all the pieces, and the Battery Commander should remedy it himself and not allow each gun pointer to use his own judgment.

Inaccurate setting by the pointer rarely occurs and is inexcusable when it does happen. The chief of detachment or a spare man should be instructed to check this setting before commencing to fire, this can very easily be done. That and a proper training are the only remedies.

No. 5 is far and away the most prolific source of lateral deviations, and to attempt to correct that by allowing the gun pointer to observe his splashes is ridiculous. In the first place if he will fire when off the target, he cannot be relied on to observe the splashes. accurately (assuming that he could pick out his own) and even if he did, it would be of no value, as he might be on the target when he fired the next time.

Errors 1, 2, and 4 above, are the only errors that can be corrected at each individual gun, one of those is negligible and the other two are inexcusable and can be guarded against. If the shots are well bunched laterally, but off the center of the target, it indicates an erroneous initial correction and the Battery Commander should correct it for all guns alike, treating the battery as a unit. It is not necessary for him to have an instrument to do this. By knowing the angle subtended by the target's length at the range of the firing, he can estimate the necessary correction with sufficient accuracy. If the shots are wild with some on and some off the target, particularly if some are on one side and some on the other, it indicates faulty gun pointing. The only remedy then is to sound "Cease Firing" to steady the men and start afresh. Corrections, however derived, are valueless.

Finally, every Battery Commander of a 3-inch battery has doubtless been the recipient of various reports from gun pointers of the travel of target during time of flight, readings taken at the same time varying °.05, and sometimes as much as °.10, from each other. If such a comparatively easy operation cannot be taken accurately in cold blood, how much value is to be placed on corrections made by the same men during the stress of firing, based on the harder task of observing splashes? Not that this is entirely the fault of the pointers, it is not an easy matter to make such observations. Put two officers with sights on Hagood tripods, or with azimuth instruments, to get lateral deviations and they will not agree throughout, and that is easier than with a sight mounted on a gun. As a matter of fact, the Battery Commander can estimate the deviations just as accurately, using the known length of the target as a guide, and with a great deal less trouble and confusion.

In my opinion the sooner Battery Commanders of rapid fire batteries discard the system of having their gun pointers observe splashes, and also, insist on accuracy, rather than rapidity, of fire, the better it will be for our target practice records.

Some experiments which were made at this post last year in connection with 3-inch target practice, may be of interest to commanders of similar batteries.

Under authority of the District Commander, the writer had the splashes in some of the 3-inch practices photographed, and it was found that it could be done without great difficulty. Two cameras with operators were used and two assistants. One of the latter watched the splashes, counting out aloud as the shots fell, the other recorded. A splash from a 3-inch projectile remains visible from three to six seconds, depending on the state of the water, and the camera operators exposed alternately at intervals of three to four seconds. The recorder had a blank prepared, with a column for each operator, and when a camera clicked, he noted in the proper column the number of the last splash announced by the other assistant. It was thus known at just what splash each exposure was made, and it was not difficult to read the films afterwards. In this connection it should be noted that it is easier to see on the film than it is on the print taken from it, particularly if the film is at all thin; a splash is frequently quite clear on the latter and yet cannot be seen at all on the print. Fig. 5 affords an illustration of this. Three splashes, indicated above, are there barely discernible, but are quite distinct on the films. Another is shown in Fig.3.

A splash frequently appears on two consecutive films. The distance from the target, and its general appearance (being less distinct on the later film) are usually sufficient to show which splashes are thus duplicated.

The photos accompanying this are from a practice thus photographed, and show fourteen different splashes; the first and one near the last being lost. It makes very little difference which particular one is lost, the point to be careful about is in the duplication of splashes. It is better to reject than to record two shots where there was really only one. As an example,

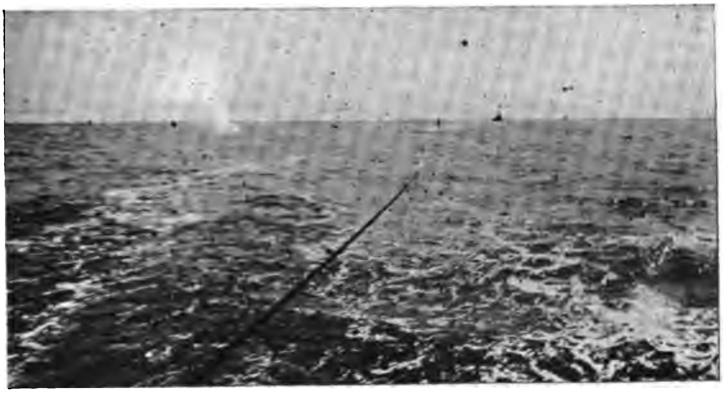


FIG. 1. SHOT 2

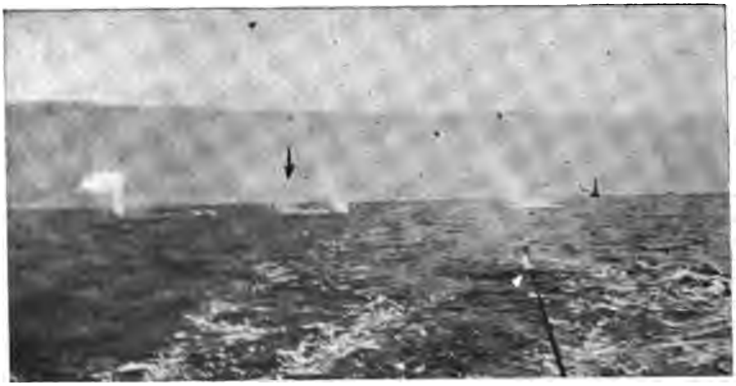


FIG. 2. SHOTS 2 TO 5

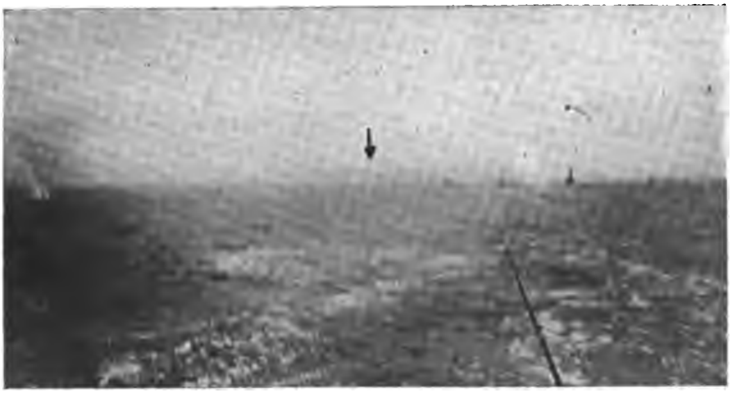


FIG. 3. SHOTS 6 TO 9

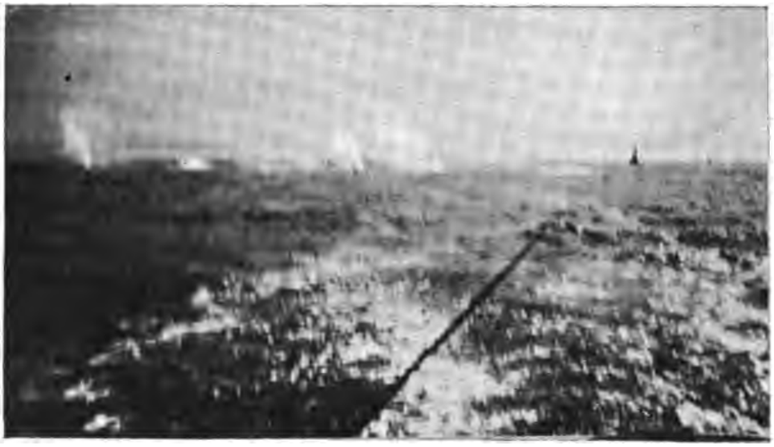


FIG. 4. SHOTS 8 TO 12

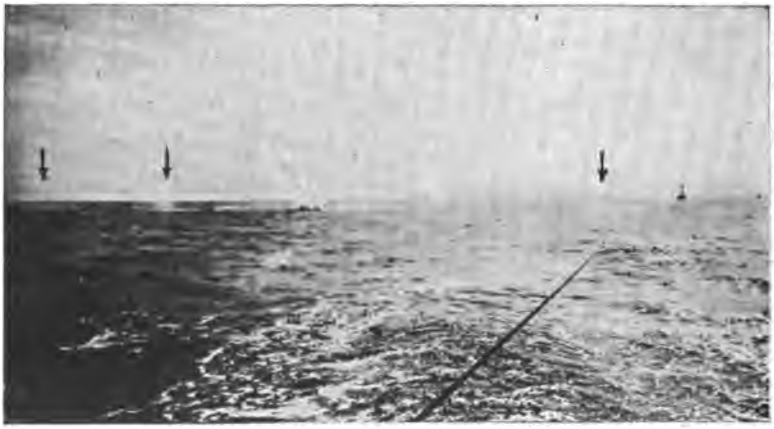


FIG. 5. SHOTS 11 TO 16

take Fig. 5. A little to the left of the target will be seen three splashes very close together. These have been considered as one splash. It may be more, (there is one missing about that time) but there is no certainty on that point, and to be on the safe side, the appearance is attributed to the projectile skimming the surface of the water before rising on a ricochet. The splash in Fig. 1 and the one marked in Fig. 2 are plainly the same splash, being caused by the second shot. Experience has shown that ricochets are always too far off to be included in the field of the lens, so there is no danger of mistaking a ricochet for a first splash.

The center of impact, determined from these fourteen splashes was 40 yards over, the extreme deviations being 6 yards short and 97 over. The actual range, as determined afterwards from the plotting board, was 1645 at the first shot and 1630 at the end of the series. Making allowance for the fact that the first two shots were fired from one gun before the other three commenced, the mean range was 1635 yards. This gives 1675 as the range to the center of impact. The guns were laid on a corrected range of 1660. The first two trial shots fell at the range of the target, the third was 32 yards over, giving an average of 11 yards over. Therefore, had the record shots conformed exactly to that result, the range to their center of impact would have been 1671, varying only four yards from that actually obtained, as determined from the photos.

The danger space was about 125 yards, so all were direct hits for range, except one short. There were ten actual hits on the target, all being in the front half, which would indicate that the deflection announced by the B. C. was erroneous and caused the misses.

Seven of the fourteen splashes were in a zone 24 yards wide, 12 yards on each side of the center of impact. Since the width of the 50% zone is twice the probable error, this would indicate that the probable error of that battery was about 12 yards. It is only an indication of course, as the guns were not laid with sufficient accuracy, nor was the rest of the data obtained with the necessary precision, for a proper determination of probable errors, but it clearly shows what the guns are capable of doing.

Photos thus obtained and used in connection with the firing data, can be made of great value by a B. C. who wishes to trace his errors and improve his shooting, and who wants to know what his guns will do.

A SIMPLE METHOD OF INDICATING AND IDENTIFYING TARGETS

By Captain HAROLD E. CLOKE, Coast Artillery Corps

The following method of identification and indication of targets has been tried in the first fire command at Fort Williams, Maine, for over two years.

The system is so simple and easy to understand that it seems unnecessary to go into many details. The fundamental object of the system was to reduce it to basic simplicity, rapidity and reliability. However, in order to make it clearly understood I will illustrate it by explaining the conditions which actually obtain in this particular fire command.

The command is composed of four batteries B-1 (two 6″), B-2 (two 12″), B-3 (two 10″) and B-4 (three 10″).

They are designated as B1, B2, B3, and B4 for convenience. Each primary and B. C. station phone are bridged on the fire commander's line. The booths in the F. C. station are connected to the observing room by speaking tube and a megaphone is connected to all tubes coming into same. The fire commander's observation telescope is supplied with a scale and pointer and the telescope with a vertical hair. This was done at the post. The scale reads to even degrees only.

The time interval system differs from the standard in that the old style master clock is connected to the signal busses at the F. C. S. B. room and a strap switch with vibrator is installed in the observing room near observation telescope of the fire commander's station. It is thus seen that all time interval bells ring simultaneously and by means of the key and vibrator the fire commander can give a signal to all batteries at the same time.

No permanent change in the standard fire control system has been made. To change to the standard would require but a few seconds.

In order to obviate the necessity of plotting, predicting and relocating, a tabular difference chart has been computed for each observer at the primary station and the B. C. Station of each battery. These tables hang over the eyepieces of each instrument. There are two stations which require no relocation as they are but 10 or 15 yards distant from the fire commander's. The B. C. stations, however, require difference tables.

Sample of Azimuth Difference Table.

All azimuth differences are to added. F′ to B-3.

Azimuth °	Range – Yards.						
	8000	7000	6000	5000	4000	3000	etc.
	°	°	°	°	°	°	
220	0.50	0.60	0.75	0.90	1.10	1.50	
230	1.05	1.30	1.40	1.60	1.95	2.80	
240	1.40	etc.					
250	1.80	"					

The method then is as follows: The fire commander turns his telescope on the target to be identified and commands: B1, B2, B3 or B4, or All Batteries, Target-Azimuth 212.00, Range 4500. This is conveyed simultaneously to the primary and B. C. stations designated. The azimuth is "set forward" and the range estimated by the fire commander in round numbers. The approximate range only is understood by the primary and B. C. stations. Each observer at the primary and B. C. stations now adds or subtracts mentally the azimuth difference as shown on the tabular difference chart card and sets his instrument at the relocated azimuth.

The fire commander now waits until the target passes the vertical hair of his instrument and when it does he presses the strap key and thus signals each station. The target selected should now be very close to the vertical hair of the observing instruments of the primary and B. C. stations. After a litttle drill it has been found unnecessary to indicate by any "set forward" point at all. The target can be indicated very readily by sending in an azimuth slightly in advance of the target and an approximate range. Azimuth instruments are all that are necessary for identifying at the primary or the B. C. stations.

There is another advantage in equipping the whole fire command with a simultaneous time system and that is in checking one horizontal base with another or one horizontal with a vertical. It works very nicely in orienting instruments where datum points are scarce. Another advantage is in the firing of salvos. The fire commander can with his key and vibrator indicate the time to fire a salvo if all batteries can keep their guns on the target at all times,—so that when all batteries have reported ready, the salvo can be fired.

Of course the simplest method of all in indicating targets is to tell *what* it is and *where* it is. But this is not so easy to execute in practice as it sounds in theory. There have arisen many cases in my experience when it has been *impossible* to identify by this method although it can be done in the majority of cases.

This system could properly be called an "azimuth-difference-table" method. If it is practiced always, it is quicker than the method by description and it is always reliable, if the battery commander reports after each identification a simple description of the target identified.

The data for the construction of these difference tables can be taken from the fire commander's plotting board by inserting the pantograph arm in the hole corresponding to the station required and tabulating the differences in azimuth between the limits of the sector of fire for every 500 or 1000 yards range and for every 5 or 10 degrees.

Another method of determining the relocated azimuth as well as range and which is simple and easy to construct at the post and which can be used on the harbor chart is as follows:

Buy a bristol board protractor with a radius of 4 to 6 inches. Number the circle so as to include the entire sector of fire of the battery. Plot the station for which relocations are to be made by polar coordinates, that is if the station be at 275 degrees and 350 yards from the F′ make a point with a circle around it at that position on the protractor. If this bristle board be mounted on a tin back and a small pin be soldered into the center as a pivot it will be found more convenient.

To use the device: Set the range arm at the range and azimuth of the target on the harbor chart. Slide the protractor till the pin is at the given range, then turn the protractor until its azimuth circle intersects the range arm at the given azimuth (facing the zero of the range arm the protractor should be used with the semicircle *from* you). Now move the range arm until its edge cuts the station to be relocated. The relocated azimuth is read on the azimuth circle of the harbor chart and the relocated range on the range arm direct.

This form of difference chart has been used by a six-inch battery at this post for over a year. I first used it at Fort Baker, California, in 1902. It was found satisfactory in every respect save one and that was durability. The paper mounted on tin peeled off and the numbers printed on it wore off. The pin through the center was also poorly soldered in and worked loose by the end of the season.

An aluminum circular disc 4″ in diameter, nicely graduated, with a beveled edge and a neat substantial center pin would be found most satisfactory, I am sure, for all batteries requiring difference charts, or in fire commands that were not provided with any better means of relocation.

PROFESSIONAL NOTES

THE EROSION OF GUN TUBES AND HEAT PHENOMENA IN THE BORE OF A GUN

By CAPTAIN H. J. JONES, A. O. D., Inspector of Ordnance Machinery

(Extract)

No. I

The erosion of gun tubes has long been the most intractable problem connected with the employment of heavy ordnance, and current progress being in the direction of increasing the caliber of the largest guns the problem of erosion has become of very great importance. The employment of guns of a large caliber is probably due to recognition of the very great destructive effect of large capacity high explosive shell; and the gradual increase of muzzle velocity to the importance of flatness of trajectory, and length of danger space. But these undoubted benefits involve the grave disadvantage of a shortened life to the inner tube, and of greater irregularity in the performance of individual guns of the same nature and mark.

The following is an attempt to bring into prominence the principle factors concerned in the erosion of gun tubes, and to indicate some quantitative aspects of the operation:—

CHARACTERISTICS OF EROSION ESTABLISHED BY GENERAL EXPERIENCE

1. Erosion appears in two forms (*a*) a general enlargement of the bore, called wear; (*b*) a local guttering or pitting, called scoring.

2. A gun may exhibit contemporaneous wear and scoring, or pronounced wear with little scoring, or pronounced scoring with little wear. The mode in which erosion will probably appear is determined, for any specified steel and ballistic conditions, by the ratio of cubic inches of gas to square inches of exposed surface at the position of maximum pressure; but the character and rate of progress of erosion depends also on the quantity of heat produced per unit weight of the propellant, and probably on the percentage volume of CO_2 and steam in the products of combustion, and the effect of the solid products of combustion on the emissivity of the surface of the bore.

3. A gun, which has less than about 1.3 to 1.4 cubic inches of gas per square inch of exposed surface—including the obturator and base of the projectile—at maximum pressure, will usually wear only for a short period of the probable life of its inner tube, scoring beginning at an early stage.

4. A gun, which has more than about 1.3 to 1.4 cubic inches of gas per square inch of exposed surface at maximum pressure, will usually wear for a considerable period of the probable life of its inner tube before scoring begins. These figures refer to modern types of ordnance using a nitrated cellulose

propellant of the cordite type. The guns would be from 45 to 50 calibers in length, and have a muzzle velocity from 2500 feet to 3000 feet per second, with maximum pressures from 17.5 to 20 tons per square inch. With these guns the ratio V—cubic inches of gas—to S—square inches of surfaces—at maximum pressure, varies from about 3.00 for a 12-inch to 1.43 for a 6-inch, and 0.45 for a three-pounder. Owing to the above-mentioned fact, that scoring begins at an early stage with guns below from 5-inch to 6-inch caliber, and at a later stage with guns above 6-inch caliber, it is usual to condemn—for replacement of the inner tube—the smaller natures when scoring has reached a prescribed limit, and the larger natures when wear plus scoring has reached a prescribed limit.

5. The wear of individual guns of a specified nature, after firing an equivalent number of full charges, approximates to the mean wear for all guns of that nature, but these guns may show very remarkable differences in the rate of progress of scoring.

6. The rate of progress of erosion is greatly accelerated by rapid continuous firing.

7. Propellants are often said to give characteristic wear and scoring, until scoring becomes excessive. Thus the wear with nitrated celluloses is more, generally, than the wear with charcoal powders, but the scoring is less. Charcoal powders frequently gave practically no wear, but excessive scoring. It must not be overlooked, however, that as improved propellants are taken into use, so also are improved steels, and better methods of forging and heat treatment; so that the erosive properties of charcoal powders, for instance, as compared with cordite, have been determined from general experience with an inferior grade of steel, and lower pressures and muzzle velocities than those now in use.

8. With the loading density common to modern ordnance the character of erosion appears to be unaffected by the form of the propellant elements, provided the elements are such as to give moderate rates of pressure rise, and retain throughout combustion their characteristic geometric form. With multi-perforated powders there is great danger of the propellant elements being broken up into small pieces, giving rise to excessive pressures and temperatures.

9. The lands are usually worn considerably more than the grooves, particularly with high velocities and large calibers. Exceptions, however, have been noted. The wear is usually taken to be indicated by the increase in diameter of the bore, measured across the lands; but it is to be noticed that this increase in diameter may not be due to wear—removal of metal—at all, but to flattening of the lands by the pounding action of the steel projectile, which is known to have excentric motion down the bore. It appears to be general for all calibers that wear proceeds at a decreasing, and scoring at an increasing rate. Thus with a modern Q. F. field gun of about 3-inch caliber the average wear of the bore, excluding the scored area at the commencement of the rifling, is about one-thousandth of an inch per 100 rounds for the first 500 rounds, one-half of this rate for the next 500 rounds, and practically ceases after 1500 to 2000 rounds.

Scoring begins indifferently at the topsides, or bottom of the bore, and wear is rarely uniform, the bore increasing in diameter sometimes vertically, sometimes horizontally, varying throughout its length.

11. Scoring usually commences on the front slope of the chamber, an inch

or so immediately in rear of the commencement of the rifling. The bore will be scored for the first 2 to 10 calibers of the rifling. Scoring appears first as isolated patches, or as narrow strips of considerable length, the strips and patches ultimately merging as scoring proceeds. Scoring usually occurs first on the driving edge of the rifling, and along tool marks, &c.; the bottom of the grooves and the loading edge of the rifling remaining smooth. Ultimately the first few calibers of the rifling may be obliterated, the eroded area being gradually extended towards the muzzle and not towards the chamber. When short cartridge cases are in use with Q.F. guns, annular erosion occurs immediately in front of the case, for half an inch or so, the remainder of the chamber to the front being comparatively clear.

12. Scoring is practically unknown at the rear end of the chamber, or in an explosion vessel, provided no leakage of gas takes place; and wear is not appreciably affected by altering the material of the driving band.

13. With a gun of given length of rifling, an increase in muzzle velocity is invariably accompanied by an increased rate of erosion, when using the same nature of propellant at a higher loading density.

14. The erosion of a gun steel appears to have little dependence on its physical properties, tensile strength, hardness, specific heat, conductivity, &c. But a small alteration in structure, and the nature and extent of forging done on the metal, together with the efficiency of the heat treatment, greatly affects the power of resisting erosion. This is to be expected, since erosion is primarily a question of heat transfer to the skin of the rifling, and the resulting alteration of structure in the metal affected; and the heat transfer depends greatly on the mere roughness and emissivity of the surface of the metal.

15. According to present practice a $\frac{3}{10}$ to $\frac{4}{10}$ per cent. forged carbon steel is found to be the best for resisting erosion. The nickel and nickel-chrome ferro-alloys, are not in general use for inner tubes, although they may be employed for outer jackets, &c. The nickel ferro-alloys appear to be particularly susceptible to changes in heat treatment, modifications of structure taking place at comparatively low temperatures, giving rise to a want of uniformity throughout a forging. A higher percentage of carbon content than about $\frac{4}{10}$ per cent., gives a crystalline steel liable to excessive scoring; a percentage below $\frac{3}{10}$ to excessive wear.

16. The erosive properties of a metal are usually investigated by exploding charges in an explosion vessel or an A.P. projectile, fitted with a plug, tapped to carry a small cylinder of the metal to be tested. The cylinder would have a through conical or cylindrical vent of from 0.15 inch to 0.20 inch diameter and about 4 inches in length. The ability of the metal to resist erosion is indicated by the enlargement of the vent and the loss of weight of the cylinder.

17. Microscopic examination of the bore shows that the surface of the rifling is covered by a network of fine hair cracks, very similar to those found on dies and the flanges of locomotive wheels. These cracks, or skin fractures, are filled with particles of the material of the driving band. The general direction of the cracks is along the rifling, and they are most numerous on the driving edge. Short transverse cracks, about 0.1 inch in length, are also found. The front slope of the chamber frequently exhibits perfect examples of a symmetrical distribution of these skin fractures, the cracks being disposed at 120 degrees to each other, like the cracks in a dried film of mud.

18. The erosion of metallic surfaces by the action of liquids or gases

is not uncommon, but in all cases, excepting that of cutting by the oxy-acetylene flame, the action takes place at comparatively low temperatures and at an extremely slow rate, many hundreds of hours' continuous action being necessary to produce an effect comparable to that exhibited by an eroded gun tube. The gradual enlargement of leaks in castings when under hydraulic or steam pressure and the local erosion of propeller and turbine blades are cases in point. Parsons, for instance, found that wet steam at a high velocity exercised a marked eroding effect on hard metals, and, as a consequence, the steam velocity in a Parsons turbine is much lower than in other types. A hand file was placed in a jet of wet steam issuing at 100 lb. per square inch absolute into a vacuum of about 1 lb. absolute. After 145 hours the steel was eroded $\frac{1}{82}$ inch deep, as if it had been sand blasted. In other cases of erosion chemical or electro-chemical action plays an important part, metallic oxides being formed, which are removed by the mere abrasive action of the gases. The oxy-acetylene torch, with acetylene and oxygen issuing at about 10 lb. per square inch, will cut a 1 inch slot in the edge of a 1 inch steel plate in less than 6 seconds. In this case we have temperatures of the order of 3000 degrees Cent., but a comparatively low gas velocity.

Consideration of the above general characteristics of erosion leads to the conclusion that the erosion of a gun tube must be due, either separately or conjointly, to—

1. The mere mechanical abrasive action of the highly heated gases, the unburnt portion of the charge, the driving band, or the body of the projectile on the skin of the rifling, which has been raised in temperature by contact with the white-hot gases.
2. The chemical action of the products of explosion.

* * * * * * *

—*The Engineer*, March 24, 1911.

---

* * * * * * *

EFFECT OF TEMPERATURE ON THE SKIN OF THE RIFLING

We have seen from the general characteristics of erosion that two distinct features are present, one of which—scoring—proceeds at a rapidly increasing rate, when it has once commenced; and the other—wear—which is general throughout the bore, and proceeds at a decreasing rate. And when we examine the surface of the bore itself, whether scored or worn, or not, we note that it is covered with a network of fine hair cracks, and has taken on a glass hard surface, which frequently cannot be worked by a file or scraper. The fine hair cracks are most numerous where the metal is exposed to the highest temperatures, and where the pressure of the driving band and body of the projectile on the rifling is greatest. It is thus important to note the nature of the forces which act on the surface of the rifling.

A modern projectile, when loaded in a gun, does not lie axially with the bore. It is more or less supported, at the rear, by the grip of the rifling on the driving band, and since the clearance between the diameter of the projectile and the diameter of the bore across the lands is from 0.04 inch to 0.05 inch, it follows that the fore part of the projectile is resting on the rifling, and the base is held obliquely by the driving band. On ignition of the charge the band is engraved, and the forward motion of the projectile causes the nose of the shell also to take the rifling. With a uniform twist it is possible that the projectile may proceed down the bore with the nose as well as the driving band carrying the rotation thrust; but with a variable twist some readjustment must be made, since the rifling at the nose will tend to give one speed of rotation and the rifling at the driving band another speed. And the readjustment consists either in distorting the band, or in re-engraving it or the nose of the projectile, the familiar multiple engraving being the result.

But, in addition, we have to note that the bore of the gun is by no means rigid. A 12-inch 50-caliber gun has a length of about 36 feet unsupported in front of the cradle, and this very stiff cantilever has a maximum deflection of the muzzle below the prolongation of the axis of the bore at the cradle of about 0.2 inch, corresponding to an angular deflection of between 4 and 5 minutes at the muzzle. The unsupported muzzle, on the imposition of firing stresses, vibrates about its fixed end in the cradle, from 130 to 140 vibrations per second being the average for a 12-inch 50-caliber gun wired to the muzzle. It is thus seen that, not only is a projectile eccentric to the bore from the first instant, but that also it has to partake of the vibratory movement of the muzzle as it proceeds down the bore; and since the center of the muzzle moves through a distance of about ⅜ inch up and down, during the time the projectile takes to pass down the bore, it is obvious that there must always be a radial thrust on the top of the lands acting on the projectile to make it conform to the vibratory state of the bore at the particular instant. Since the clearance is small, it is probable that about one-sixth of the lands are under pressure from the nose of the projectile at any time. In the old short and rigid smooth bores, with large windage, the projectile proceeded down the bore, bouncing from one side to the other. In the modern gun of great length the same bouncing action takes place, but due to a different cause.

Taking the instant when the projectile is at the muzzle, and assuming the simple case of simple harmonic vibration of the bore, we are able to calculate the acceleration of the bore in a direction transverse to the motion of the projectile, and this must equal the transverse acceleration of the projectile itself at that point. Multiplying by the mass of the projectile, we have a measure of the total radial thrust of the bore on the side of the projectile, and hence of the intensity of thrust on the lands. Calculation shows that for a gun of the type of the modern 50-caliber 12-inch, a flattening of the lands is to be expected at the muzzle; and probably excessive wear. Since, as a rule, the bottom of the grooves would not be in contact with the body of the projectile; the wear and increase of diameter would be confined to the lands alone. Experience shows this to be the case.

Also it is to be expected that the continued pounding and scrubbing action of a steel projectile on the top of the lands will result in the surface becoming hard and polished, and give rise to skin fractures, indicating increases in surface density, irrespective of any temperature effect. And hence, if we look upon the general wear of the bore, excluding the part where scoring takes place, as due in the main to the friction of a steel projectile, and not to the gaseous products, we get an explanation of the fact that wear proceeds at a decreasing rate. The surface of the bore is at first comparatively soft, but the scrubbing action of the projectile—quite distinct from the friction of the driving band—aided by the heatings and quenchings on firing, causes the surface, particularly the top of the lands, to become smooth and hard, and thus the removal of surface material by the mere forces of friction is retarded. Further, it is to be noted that an enlargement of the bore does not necessarily mean wear; at the muzzle, at any rate, it would generally mean the flattening of the lands.

The effect of violent temperature strains in the skin of the rifling is to produce the well-known shrinkage cracks, and when the maximum temperature approaches the A C_1 point, to cause very profound changes in structure, these changes being probably facilitated by the friction of the projectile, the driving band, and the products of combustion. Guillet has examined the modification of structure in the edges of a cut made by erosion with an oxy-acetylene flame. He found the change of structure was quite local, only a small thickness of metal contiguous to the cut being depreciated in value. Harbord has found a similar modification in the cut made by a toothless circular saw, the temperature in this case being purely a friction effect. Micro-sections from the bottom of the saw cut showed that the intense local heating had changed the normal structure of ferrite and pearlite to a confused structure, and in some cases the change was so marked that a definite structure was entirely absent.

Beilby has also carried out most fascinating researches into the structure of the surface films of ductile metals. He has shown that the surface film of a metal behaves as if the solid particles were liquid. Under the microscope a polished or abraded surface appears covered with a viscous fluid, the surface molecules exhibiting a remarkable mobility under the action of heat at comparatively low temperatures, and by the mere mechanical strain of abrasion. The early appearance of erosion on the driving edge of the rifling is probably due to this modification of surface structure under heat primarily derived from friction with the projectile.

COMPARATIVE EFFECT OF FULL AND REDUCED CHARGES, AND THE LIFE OF INNER GUN TUBES

A most important feature of erosion is its lessened rate of development with reduced charges. And since, for purposes of economy, most of the life of an inner tube is spent in firing reduced charges, it is necessary to formulate rules governing their effect, so that guns of the same type, which have fired different proportions of full and reduced charges, may be directly compared.

Charges are compared by weight, and the rule governing British ordnance is that one full charge = 4 three-quarter charges = 16 half charges. That is to say, the same shortening of the life of an inner tube is brought about by firing 1 full, or 4 three-quarter, or 16 half charges.

Judging from the maximum temperatures, pressures, and the velocity at maximum pressure; and noting the rules in use elsewhere, one is inclined to believe that the effect of reduced charges is considerably understated in the above rule, and that, in fact, the one rule cannot be made to suit all natures of gun. Erosion, besides being a matter of temperature and velocity, is also one of quantity of heat, and the ratio of volume to surface.

An estimate based on considerations of the quantity of heat absorbed by the walls leads to the conclusion that for a gun of 12-inch caliber, the rule should be 1 full = 2 three-quarter = 6 half charges.

For a gun about 6-inch caliber, 1 full = 3 three-quarter = 12 half charges.

And the first quoted rule, for guns about 3-inch caliber. But actual experience can alone decide.

—*The Engineer*, April 14, 1911.

* * * * * * * * *

THE CAUSES OF EROSION

Guns of a modern type, namely, with a length of 50 calibers and a muzzle velocity from 2500 feet to 3000 feet per second, differ not only as regards the ratio of volume to surface, but also in the size of the propellant elements and the mean velocity of the projectile whilst in the bore. Thus, the nominal diameter of the cords for modern heavy guns is as follows, the numbers representing the diameter in hundredths of an inch of the die through which the cordite is pressed:—

Gun	12 in.	9.2 in.	7.5 in.	6 in.
Diameter of cord (cordite M.D.)	0.45	0.37	0.26	0.26

On the other hand, the length of the rifling in calibers is—

Gun	12 in.	9.2 in.	7.5 in.	6 in.
Travel of projectile, calibers	40.6	40.0	42.6	44.3

And since the muzzle velocity is about the same for all four guns, it follows that the mean velocity of the projectile in the bore is considerably higher in the 6-inch than in the 12-inch; in the 12-inch the muzzle velocity of about 3000 feet per second is reached after a travel of 40.6 feet, and in the 6-inch after 22.15 feet.

From the above, two important results follow. We see that increasing the caliber means increasing the size of the propellant elements, and thus reducing the surface of combustion per pound of the charge. The travel of the projectile, up to the occurrence of maximum pressure, is as follows:—

Gun	12 in.	9.2 in.	7.5 in.	6 in.
Travel of projectile to maximum pressure (in calibers)	6.5	5.48	5.12	4.27
Travel (in feet)	6.5	4.2	3.2	2.13

On the other hand, at maximum pressure, owing to the greater acceleration of the smaller projectile, the velocity of the projectile would be of the order of 500 feet per second for the 12-inch and 800 feet per second with the 6-inch, these figures being understood to be average figures.

Now the charge is completely burnt at about 2 calibers after maximum pressure; so that from the above we note that an increase in the caliber not only means an increase in $\frac{v}{s}$, but also in the total time to which the bore is exposed to the hot gases, and in the time of exposure when the temperature is highest. A modern 12-inch gun not only has 3 cubic inches of gas per square inch of exposed surface at maximum pressure, as compared with 1.43 cubic inches for the 6-inch, but the time of exposure to the maximum temperature is about 4.5 times as long.

Erosion, then, is fundamentally a question of heat transmission, and the pounds, shillings, and pence of the action is determined by the proportionate effect that the various factors—temperature, quantity of heat, pressure, and time of exposure—have on the total heat units transmitted.

The maximum temperature is determined by the density at maximum pressure, and is, for the same propellant and within narrow limits, the same for all guns of the type discussed. The quantity of heat from combustion in relation to the surface exposed varies according to the linear law $\frac{v}{s} = 0.26d + 0.12$, and is thus, for large calibers, practically proportional to the caliber. The maximum pressure within narrow limits is also the same for all guns. On the other hand, the time of exposure to the gases, when they are at the highest temperature, varies almost as the square of the caliber.

For British guns the quantity of heat transmitted at or about the position of maximum pressure has been reduced to a quantity proportional to $\frac{1}{v^2\,d\,(d-2)}P^{1.7}$, and the calculated life based on this rule is as follows:—

Table Showing Estimated Probable Life of Modern Guns, using Cordite M. D. Charges.

Caliber	Muzzle velocity and maximum pressure.		
	3000 f.s. 19 tons.	2750 f.s. 18 tons.	2500 f.s. 17 tons.
in.			
13.5	120	155	210
12.0	155	200	270
9.2	280	365	490
7.5	450	590	785
6.0	775	1010	1350

$$\text{Calculated by rule, } L = \frac{2.5 \times 10^7}{v^2 d(d-2)} P^{1.7}.$$

Where L = Life in equivalent full charge rounds.
v = Muzzle velocity in thousands of feet per second.
d = Caliber in inches.
P = Maximum pressure in tons per square inch.

The above estimate, which indicates the probable life before the various guns would be sentenced for repair during peace, must not be taken as an indication of the limit of useful life of these guns on service. Obviously, if guns were allowed to remain mounted in commissioned ships until the limit of the useful life of their inner A tubes had been reached, it might happen that, on mobilisation, a considerable proportion of the guns would be within a few rounds of their limit of serviceability, from the point of view of consistent shooting. It is probable that the above estimate, for purposes of repair; can be increased from 30 to 40 per cent. to give the actual life of serviceability.

It follows from the above general considerations that erosion can hardly be due to escape of gas over the driving band. In the first place, the velocity of the gas over the band would be very high, b[illegible]ime of exposure at any place will be exceedingly small. In the second place, a thin stream of gas rushing over the driving band would be rapidly cooled, and in any case, if erosion of the steel be due to gas escape over the band, we should naturally expect the band itself to suffer great erosion; but, as a matter of fact, band erosion is most uncommon. It is also apparent, that since gas escape is greatest over the bottom of the grooves, where the radial thrust on the band is at a minimum, erosion should occur at first on the bottom of the grooves if it be due to leakage; but, as a matter of fact, erosion occurs first on the driving edge, where the pressure is greatest and where there is probably no gas escape at all.

REMEDY FOR EROSION

The question now arises as to the remedy for erosion. From the preceding remarks it will have been gathered that although quantity of heat, velocity at or about the position of maximum pressure, and the density of the products of combustion at maximum pressure are important, in so far that they concern the rate of heat transfer, yet the predominating factor is mere temperature. The quantity of heat absorbed by the walls is proportional to the temperature difference when by conduction and convection; but to the fourth power of the temperature when the transfer is by radiation. And from cooling curves, taken with fired charges giving pressures and temperatures corresponding to those found in a gun, we infer that in the early stages of cooling radiation plays the most prominent part.

It has also been seen that the remedy for erosion is not to be sought for in the discovery of a steel having a high melting point, or conductivity, or degree of hardness. The heat transfer is mainly a question of the condition of the surface; and erosion, of the modification of surface structure under violent temperature and purely superficial strains.

And, further, we are not, even in a remote sense, concerned with mere economy, namely, in getting as many foot-pounds of energy per pound of charge as possible out of our ammunition. Provided changes in ammunition, to insure a longer effective life of an inner tube, do not involve a disproportionate increase in weight of the charge, we are not at all concerned with a lower heat efficiency from our gun considered as an engine.

Modern heavy guns have already reached the limit of permissible length. Whether "solid" or wire-wound they have considerable muzzle droop, and generally excessive "whip"; and, in addition, a large proportion of their length is exposed and unprotected. Consequently, for heavy guns of the present type, that is, 50-caliber guns with a muzzle velocity of from 2500 feet to 3000 feet per second, and having chamber volumes such that at maximum pressure there are from 2.5 to 3.5 cubic inches of gas per square inch of exposed surface, the only remedy for erosion consists in reducing the maximum temperature and increasing the mean pressure. In other words, the indicator diagram of a gun has to be modified from the typical internal combustion engine type to that of a steam engine with a late cut-off. The length of the gun and the number of expansions, as well as the maximum pressure, being limited, the proposal to increase the mean pressure involves an increase in muzzle pressure. And an increase in muzzle pressure means a less efficient heat engine, and objectionable blast features for guns mounted in ships.

To reduce maximum temperatures and increase mean pressures, we have to make use of composite charges. At the present time in the British Service composite charges consist of a main charge of cordite M.D., made up of propellant elements of a uniform shape, and a small percentage of the same propellant made up into elements of small size. The small size, exposing a large surface, is easily ignited, and burns quickly, and thus facilitates the uniform inflammation of the larger elements. The charge is thus only composite as regards the mere dimensions of the elements; chemically, the charge is uniform.

But it is proposed to make the charges composite, not only as regards size, but as regards chemical composition. This may be done in several ways. The actual explosive may have incorporated with it a considerable proportion of a salt having a large weight of water of crystallisation, or such substances as graphite, and certain fats and soap, &c. But a preferable method is to mix with the main propellant a proportion of explosive having a very low potential, or even a non-explosive substance, the mixture being a mechanical one, elements of the low potential explosive being mixed with those of the main charge.

The action is obvious, and is well illustrated by the effect of incorporating mineral jelly in cordite Mark I and cordite M.D. Robertson gives the following results obtained from these propellants, with and without mineral jelly:—

Cordite Mark I. Differences due to the Admixture of 5 per cent. Mineral Jelly

Density	0.1	0.2
Heat of explosion in calories per gramme water gaseous	—217	—206
Total gases (water gaseous) cubic cents. per gramme at 0 deg. Cent. 760 mm.	+106	+115
Theoretical temperature of explosion deg. Cent.	—313	—332

Cordite M.D. Differences due to the Admixture of 5 per cent. Mineral Jelly

Heat units	—202	—170
Total gases	+100	+101
Temperature	—327	—311

Progress along these lines has already given signal results with internal combustion engines. Thus, to reduce the maximum temperature in an internal combustion engine, without a reduction in power, Clerk admitted air or exhaust products, with the gaseous charge, at a pressure of about 25 lb. per square inch. Keeping the amount of gas constant the additional pressure due to the presence of the diluent air or inert gas gives the same power output, but a lower maximum temperature, owing to the heat absorbed in raising the temperature of the inert gas. By this means Clerk with an engine 10 inches by 18 inches was able to increase the efficiency from 27.7 per cent. to 33.4 per cent., and yet lower the maximum temperature from 1700 deg. Cent. to 1200 deg. Cent. A similar result has been achieved by Crossley. When a suitable quantity of water was injected into the cylinder the efficiency was raised to 37.4 per cent., and the heat loss to the walls lowered by 29 per cent.

Composite charges of the present type act in a similar way. Being made up, as a rule, of about 95 per cent. of a large size and 5 per cent. of a small size, they burn in the following way:—The small size is ignited and burns at a comparatively low density, and hence with low maximum temperature. The large size then burns under an initial pressure of about 500 lb. per square inch, and this ensures regular and definite inflammation of the large size. The products of combustion of the small size now act as the diluent gas in

Clerk's engine, absorbing heat from the products of combustion of the large size, and thus lowering the maximum temperature.

It is obvious that this method admits of considerable development by using charges made up of elements differing not only in size, but in chemical composition. It would not be appropriate to give here the actual results of calculations made to suit British ordnance; but it is practically certain that by adopting the above "composite" principle, the maximum temperatures in heavy guns may be decreased 500 deg. Cent., to 800 deg. Cent., with a very large increase in the effective life of an inner tube.

It is interesting to note that the above furnishes an explanation of the "mystery" of the first round. It has long been known that the first round from a cold gun shoots considerably over the mean point of impact of subsequent rounds fired at the same elevation. This is often explained by saying that a cold gun is usually well lubricated with presevative materials, mineral jelly, &c., so that a smaller proportion of energy is lost in friction. But is not the real explanation, that the first round is fired with the chamber dry, whilst subsequent rounds are fired with the chamber wet, after sponging out; and that the loss of ranging power is due to the heat energy absorbed in converting the chamber water into steam?

A good example of the effect of adding water to the charge is given by Yarnell, in his account of erosion experiments on plugs made of gas-check pad metal. By adding 6 ounces of water to the charge, the weight of metal eroded from a plug 5 inches in length, and with a vent 0.152 inch diameter, was reduced from 19.1 grammes per pound of powder to 5.5 grammes; and the maximum pressure only increased from 14.3 tons to 15.2 tons.

—*The Engineer*, April 21, 1911.

◆ ◆ ◆

THE TYPE OF GUN FOR COAST DEFENSE

Translated from "Russki Invalid," No. 231

By A. E. HARRISON, Major, late R. A.

In Nos. 224 and 225 of the *Russki Invalid* of this year appeared articles by M. A. Nilus concerning the caliber of guns for coast fortresses, in which the author, after showing that guns were being built in many countries of a large caliber (14-inch), arrived at the conclusion that it was necessary to construct guns of still larger caliber—guns of the future, which, notwithstanding the rapid developments in ship building, would still be able for many years to come, to contend with the ships of a fleet.

Although fully sharing and welcoming the idea, I for my part, would like to say a few words on the *type* of gun for coast defenses.

If we consider the question of the armament of a battleship we see at once that this armament consists entirely of *guns*, that is to say, of long guns possessed of great initial velocity and a flat trajectory.

From this follows the idea that it is necessary to contend with your opponent with a gun of the same kind; on shore, therefore, one finds, almost exclusively, weapons for direct fire—*guns*.

Weapons for high angle fire appear to be only supplementary and hardly come into consideration.

I cannot help thinking that this is all wrong. Guns, according to the established idea, have a tremendous advantage over howitzers in striking power, in their short time of flight, in the extent of their dangerous zone and in their accuracy. But is this so?

Having mounted your gun on shore, the object is to hit the ship in a vital spot; and having pierced the armor, the object is to obtain great destructive effects.

But calculations show that even the most powerful gun of the day (12-inch) with a length of 52 calibers and an initial velocity of 3000 foot seconds can pierce 11-inch armor at ranges not greater than 7000 yards. But ranges of 7000 yards would scarcely be chosen by battleships. More probably the distance would not be less than 9300 yards, and only after the advantage has been gained by the ship, would it run the risk of nearer approach.

But one must keep in mind that it is almost impossible to hope to strike the ship perpendicularly, that at such ranges, there is a considerable angle of descent (6 or 7 degrees), and that generally the fleet when maneuvering, would keep on a loxodromic curve, *i.e.*, so that its diametric breadth would present to an enemy on the battery a certain definite angle—the angle of its course—of not less than 30°. At such an angle of impact, one cannot hope to pierce armor, the projectiles would glance off.

And so, one must come to the conclusion that it is almost impossible to expect to penetrate armor in actual battle.

But if the penetration of armor was an easy matter, even then armor piercing shells would not show very great destructive power.

In reality, their bursting at the desired spot cannot be guaranteed on account of the difficulty of constructing a suitable fuze; the bursting charge is small, and so the damage sustained cannot be very serious.

The experience of our last war has shown clearly the great effect of a bursting shell, and, of course, the greater the charge, the greater will be the effect.

In guns where great pressures are developed in the bore, the bursting charge cannot be large; it cannot be greater than 10 or 12% of the weight of the shell, generally it will be about 6 or 7%.

Another advantage that the gun has, viz., the short time of flight, is of importance in accurately calculating a prediction of the target's course, both in elevation and deflection.

This superiority of the gun is very noticeable if you compare a gun with a howitzer of the same caliber.

But if you allow for the increase of the caliber of the howitzer in comparison with that of the gun which is obviously possible on account of the relatively small weight of the howitzer, then this superiority of the gun is considerably diminished, although it will still be there.

The dangerous zone, generally speaking, is not of large extent at these ranges of about 10,000 yards, either for guns or howitzers, and therefore the superiority of the gun in this respect has not much significance.

As regards accuracy the gun is generally supposed to be superior, but this is a debateable point.

When firing at a vertical target, each gun is individually more accurate than the howitzer, yet this is not the case, when firing from a battery and at a horizontal target. I will give this example as an illustration.

The probable error in firing from a battery of 3-inch Q.F. field guns is 140 feet, and from the old guns of 1877 pattern, which in certain details (length of bore and initial velocity), approximate to howitzers, this error is 84 feet. Generally the difference between the probable error of an individual gun and of a battery is considerably increased by the increase of the initial velocity.

But the difference between the probable errors of a gun and a howitzer, in the case of firing from a single gun is not great. That is why, in firing from a battery, the probable error of howitzers can be shown to be less than that of guns.

In the case under consideration (firing at the ships of a fleet), the ship will present a vertical target to the gun, but a horizontal one to the howitzer. If the dimensions of the target in each be calculated, it will be found that guns have a target of about 1,440 square yards, while the howitzers will have one of about 3,550 square yards. Nearly three times as large. It is worth while pondering over this.

From what has been said it is, I think, sufficiently plain that a gun scarcely has any superiority over a howitzer with regard to its chance of hitting a ship. The sole advantage that the gun has over the howitzer appears to be in range.

But even the howitzer can attain to a range of 16,000 yards, *i.e.*, to the extreme probable range in battle.

From all that has been said above, it follows that the gun has, generally speaking, no natural advantage over the howitzer. On the other hand, the howitzer has several advantages over the gun.

First and foremost, the howitzer shell can be filled with a large quantity of explosive—up to 25% of the weight of the projectile, which with a caliber of 12-inches gives an actual weight of 240 pounds.

In the case of a gun of the same caliber, the bursting charge cannot be more than 100 pounds.

These figures speak for themselves.

The howitzer can hit the ship in its weakest spot—the deck, and, moreover, the damage will be much more serious, as erections of various kinds are distributed about the deck, turrets, observation posts, etc.

The howitzer being considerably shorter than the gun, will be considerably lighter and, therefore, when of equal caliber will be a more rapid firer. Or for an equal rapidity of fire the howitzer may be of larger caliber, and, therefore, more effective on account of the increase in the bursting charge which varies proportionately to the cube of the caliber. The shortness of the howitzer is of importance again in this respect, that it offers a smaller mark to the enemy's artillery.

The howitzer has a longer life than the gun, because it suffers less from its own discharges. The service life of a 12-inch gun is about 100 shots, but of a howitzer not less than 500.

Finally, the howitzer with its equipment, without taking its longer life into consideration, costs at the very most only two-thirds as much as the gun.

From all these considerations, I must give it as my opinion that the weapon for coast defense is the howitzer. Its caliber should be increased as far as is compatible with a reasonable rate of fire, not less than two shots a minute, which would appear to be easily attainable. Guns of large caliber should be used only in those cases where howitzers appear to be of insufficient ranging power, *i.e.*, in keeping a bombarding fleet at a distance.

—*The Journal of the Royal Artillery*, February, 1911.

✦ ✦ ✦

GUNS OR HOWITZERS

Translated from *Russki Invalid*, No. 235

By A. E. HARRISON, MAJOR, late R. A.

M. D. Kozlovski in No. 231 of the *Russki Invalid* advocated the employment of the howitzer as the principal weapon for shore defenses.

My opinion, which has been already published, is that the weak spot in our coast armament at the present time is the great number of howitzers, and I consider myself bound to protest against this new proposal—to exchange valuable long range guns for howitzers.

First of all it should be noted, that battleships of the present day are designed for fighting at very long ranges, at which the trajectory of the most powerful gun will have a big angle of descent.

Thus battleships will receive hits on deck not only from howitzer batteries ashore, but also from long range fire in a purely naval battle. Against such hits battleships are now protected, and they (the hits) are no longer so dangerous as was the case a few years back.

As regards the statement that the howitzer trajectory strikes the deck—a big target—while the gun strikes the side—a very small one—it is certainly not a correct one. At long ranges, guns will also hit the decks, and still retain their superior accuracy. The same percentage of hits that the howitzer obtains at 12 versts (8 miles), the gun will obtain at 18 versts (12 miles).

As regards the superiority of the howitzer shell in size of bursting charge, that will be considerably decreased when we require the howitzer to fire at a range of 16 versts (10¾ miles); the initial velocity, and consequently, the solidity of the walls of the shell must be increased. There will be no economy in introducing howitzers into the armament, for as the equipment is increased, so will the cost of the battery increase; larger casemates for the shells of larger caliber will be required, the mounting will be no cheaper, and the reduction of expense in the actual gun will be a negligible amount.

But let us suppose all these objections to be overruled. The main reason why howitzers can never be the chief weapon for coast defense is their slow rate of fire. A coast defense gun which has to deal with a target appearing for only a few minutes must above all excel in rapidity of fire. The nature of the howitzer admits only of the present anti-quick-firing method of firing salvoes at long intervals.

M. Kozlovski is right in this, that a howitzer can be built capable of firing two shots a minute. But in rapidity of fire a howitzer battery must always be inferior to a gun battery. It is only the ignorance of our coast artillerists of the means of attaining to a quick rate of fire which allows them to doubt this. A howitzer shell at long ranges will be a minute or a minute and a half in the air.

When firing at ranges from 12-16 versts (8-10 miles) it is impossible to dispense with a trial shot; all firing at a moving target is based entirely on the trial shot; but the commander of a gun battery will observe the fall of his shot in half the time and can, consequently, commence firing much sooner.

The position of a commander of a howitzer battery is hopeless; he sees the flight of his shells clearly and is doomed, after corrections have been made, to see them for a minute and a half longer, whilst he has no power over them as they fly through space. Consequently all the corrections are too late, and these mighty shells are hurled uselessly into space.

I think that generally the preference shown to howitzers to a great extent is due to the fact, that practice in peace time is carried out against targets moving only at one-fifth the speed that they would in warfare.

On account of the slowness of flight of the howitzer shell, the howitzer must be layed about 700 yards ahead of a ship moving at full speed, which must seriously affect its accuracy.

Generally speaking, the howitzer is not a weapon for firing at a moving target. Try to kill a wood-cock on the wing with a sling—a weapon of the same type as the howitzer.

The coast artillery think too much of their power of sinking the enemy with one shot, and too little of how they are going to hit him.

It seems to me it would be better to leave the dreams of M. Nilus's 14-inch gun and M. Kozlovski's howitzer. We must be content with our 12-inch gun, the best naval weapon. We must not be bloodthirsty, why should we sink the enemy's ships with one shot? The certainty that no admiral will bring his ships within range of a 12-inch shell should be enough.

—*The Journal of the Royal Artillery*, February, 1911.

✦ ✦ ✦

THE TYPE OF WEAPON FOR COAST ARMAMENTS

Translated from *Russki Invalid*, No. 248

By A. E. Harrison, Major, late R. A.

In No. 231 of the *Russki Invalid* I expressed the opinion that by far the most suitable weapon for coast armaments was the howitzer, the caliber of which should be as large as possible, commensurate with a certain degree of rapidity of fire.

The fundamental reason for choosing the howitzer for coast armaments is the great explosive effect of its shell. That of the gun is far less, and against armor cannot be considered at all. As the choice of the type of weapon must be based on its destructive effect and on nothing else, I beg to submit some examples of actual experience in war.

In our last war, where fighting took place at ranges of only two miles, there was a splendid chance of penetrating armor (the *Pobieda*), but it appears that a bursting shell never once got inside the ship. I cannot, of course, speak of the damage which the ships sustained at the battle of Tsushima as their secrets lie at the bottom of the sea; but what we do know bears out the statement that *there was no penetration of the armor;* there was not only no penetration of the heavy armor, but even the light armor was pierced on extraordinarily few occasions taking into account the enormous number of hits (the case of the *Orel*, for example).

The same thing was observed in the Chino-Japanese war, at the battle of the Yalu, and in the Spanish-American war at Santiago.

Once for all the penetration of armor is unattainable with our present equipment, and as the endeavor to accomplish it is responsible for the establishment of most expensive armaments, which are constantly being renewed, I ask if it would not be better to search for some other solution. There is a solution, namely, the employment of weapons which throw shells of great explosive effect.

Our war experience shows us that a common shell, even if it strikes on the most heavily armored part, sets up such a concussion that the protecting armor is shattered and cracks appear in the side of the ship, through which water is irresistibly forced.

A very good example of this was the *Retvizan* which on February 26, 1904, was hit by five common shell, one of them striking on the most heavily armored part near the waterline, at a range of nine miles; the armor was not pierced, but the concussion was such that a leak appeared which was overcome only with the greatest difficulty.

Hits from armor piercing and common shell may be easily distinguished also in the lightly protected parts by the difference in the damage inflicted.

The common shell causes damage over a surface of 100 square feet, driving into the ship rivets and portions of the hull. Besides this it discharges an immense amount of gas heated to an enormous temperature which consumes everything, and envelopes the ship for quite a long time in a dense suffocating atmosphere.

The armor piercing shell with its small bursting charge produces a comparatively slight effect, for even if it does penetrate, it makes an exceedingly small hole and as its burst takes place after penetration, the only effect is a shower of splinters.

From these considerations, it would appear that the only possible projectile against a ship is the common shell with instantaneous fuze, as its effect extends over the whole surface of the ship, and *does not depend either on the angle of impact or on the range.*

This then is one consideration which will influence our choice of weapon for coast armaments.

The other is—the range.

At the present time, one frequently hears the opinion expressed that a fleet will engage at ranges of 16 miles, that is, with weapons equal in range to those of present day ships. I think that this is an entire mistake.

Even if it be admitted that at such a range a fleet can throw shells into a fort, it cannot attain to either regular control of fire, or its direction on any particular point, or observation of the most suitable objectives. In short, at such ranges it is impossible for the fleet to fire. The height of the tops from which observations are made are about 100 feet and from this elevation the visible horizon has a radius of less than 13 miles.

Firing at such great ranges is difficult also from shore batteries. But nevertheless, they are in a better position than the fleet. The point of impact of their shells is shown by high splashes, and when using sensitive fuzes the bursts are marked by dense clouds of smoke which can be distinguished even against the back-ground of smoke which the movements of the squadron would make on the horizon.

From my own investigations I put the extreme range at from 5-8 miles. Mr. A. S.—in N. 235 *Russki Invalid* assumes ranges will be 8-10½ miles. Without going into the question in detail, I will merely say that, at ranges approaching 10 miles, it will be impossible to make observations, and it would, therefore, appear more suitable, when deciding what your type of weapon is to be, to consider ranges from 5-8 miles.

As by far the weakest portion of a ship is its deck, it is important to have a weapon which possesses at the range indicated a comparatively steep trajectory. At ranges of about 6-7 miles, a 12-inch gun with an initial velocity of 3000 feet seconds has an angle of descent of about 8½°, and as these shells are provided with delay-action fuzes they will, on striking the deck, ricochet, and their destructive effect will be absolutely nil. In the case of a howitzer of the same caliber, with an initial velocity of 1500 foot seconds, the angle of descent is 28½°, from which there will be no ricochet. In fact there could not be any, because the fuze is so sensitive, that the burst takes place the very moment of impact. (The Japanese shells burst even on touching the water.)

Thus a howitzer at fighting ranges will be superior to the ordinary gun.

The disadvantage of the howitzer is its longer time of flight. At the range given (6-7 miles) the time of flight for the gun will be about 16 seconds, and for the howitzer about twice as long. This disadvantage is a very real one, as with the increase of time of flight, comes an increase in errors in calculating movements of the objective, but in spite of this the accuracy of the howitzer is scarcely less than that of the gun.

It is true that if you take the probable errors in two directions it will show less accuracy, but this proceeds entirely from the lateral deviation, for in range the probable error of the howitzer will be even less than that of the gun. When a ship is proceeding in a direction perpendicular to that of the projectile, the target is of great breadth, not less than six times the probable error, and consequently the howitzer will scarcely give a less percentage of hits than the gun.

Only in case of movement towards or away from the battery will the ship present a narrower target. But such movements will be exceptional.

The foregoing considerations appear to be of such importance that I do not hesitate to recommend the howitzer as the principal weapon for coast armaments.

As a supplementary consideration I invite attention to the economical advantage which I pointed out in No. 231 *Russki Invalid*. The cost of guns and their equipment up to 200 rounds being about half as much again as that of howitzers.

To this I would add that because of the lighter weight of the howitzer, it can be more simply and easily traversed and, therefore, can be fixed more quickly.

The increase in the caliber of guns for battleships, with a decrease in their initial velocity is not a dream. The English have armed their new cruiser *Lion* with guns of 13.4″. In Germany they have delayed the completion of four battleships with the object of introducing a new gun of a caliber of 14.57″. —*The Journal of the Royal Artillery*, February, 1911.

◆ ◆ ◆

NEW EMPIRICAL FORMULAE FOR INTERIOR BALLISTICS

Translated by Captain George A. Wieczorek, C. A. C.

In part No. 45 of the *Artilleristiche Monatshefte* Baron von Zedlitz explains the following as his empirical formulæ, and gives some tables containing a collection of data for the experimental confirmation of them by applying them to all calibers and all kinds of arms, from small arms to naval cannon of 254 mm., charged with every kind of propellant, from fine black powder to nitrocellulose of the most modern production.

The fundamental formula of the system is

$$v = \frac{b\,x^n}{x^n + a} \tag{1}$$

in which v is the assumed velocity of the projectile when it has traversed a given space x in its movement, and a, b, and n are constants.*

From the preceding it is very easy to show that the acceleration

$$\frac{dv}{dt} = v\frac{dv}{dx} = b^2 a\, n \frac{x^{2n-1}}{(x^n + a)^3}$$

and that therefore the pressure, the force that produces the motion, is

$$p = \mu\, b^2 a\, n \frac{x^{2n-1}}{(x^n + a)^3} \tag{2}$$

in which μ indicates the "density of section" of the projectile; that is, the ratio of its mass to the area of a section normal to the axis.

The author advises calculating by the use of the empirical formula

$$n = A\left[\frac{\omega}{PL}\right]^{\frac{1}{3}} \frac{E^{\frac{5}{4}}\, d^{1\frac{1}{6}}}{\omega} \tag{3}$$

in which ω is the weight of the charge and w that of the projectile expressed in kg., P indicates the maximum pressure expressed in kg. per sq. cm., L the total length of the space passed over by the moving projectile expressed in mm., E is the "potential" of the charge, that is the outside work that would be accomplished by the gases resulting from the explosion of 1 kg. of it, if it could expand indefinitely, d is the caliber expressed in cm., and A is a constant given from

$$\log A = \bar{2}.0767.$$

Since problems in interior ballistics include generally the tracing of diagrams of pressures and velocity, or are solved by means of the solution already obtained from this, and since the data that are commonly at our disposal are the value of the maximum pressure and that of the initial velocity, together with the different parameters of loading, we begin always by calculating the value of n with formula (3), and then we may proceed to the determination of a and b, which is equivalent to the solution of the problem.

In order to calculate a the author prescribes the expression

$$a = \frac{n+1}{2n-1}\, x_m^{\,n} \tag{4}$$

in which x_m indicates the total space passed over by the projectile at the instant at which the pressure of the gases from the charge have assumed their maximum value, P, in the movement. This interesting data should in turn be calculated thus: Applying (2) to obtain the value of P, we should have

---

* Calculated by the formula of Jones in "Some Problems in Internal Ballistics," in *Rivista Marittima*, January, 1907.

$$P = \mu\, b^2\, a\, n \frac{x_m^{2n-1}}{(x_m^n + a)^3}$$

that is

$$P = \mu\, b^2 \frac{n\,(n+1)}{2\,n-1}\ \frac{x_m^{3n-1}}{\left(1+\frac{n+1}{2\,n-1}\right)^3 x_m^{3n}}$$

Then:

$$P = \mu\, b^2 \frac{n\,(n+1)}{2\,n-1}\ \frac{(2\,n-1)^3}{27\,n^3}\ \frac{1}{x_m}$$

and finally

$$P = \frac{1}{27}\,\mu\, b^2 \frac{(2\,n-1)^2\,(n+1)}{n^2}\ \frac{1}{x_m} \qquad (5)$$

Now (1) applied for the muzzle velocity gives

$$V = b \frac{L^n}{L^n + \frac{n+1}{2\,n-1} x_m^n}$$

therefore we would have

$$V^2 = b^2 \frac{\left(\frac{L}{x_m}\right)^{2n}}{\left[\left(\frac{L}{x_m}\right)^n + \frac{n+1}{2_n-1}\right]^2} \qquad (6)$$

which divided, member by member, by (5) gives:

$$\frac{\mu V^2}{L P} = \frac{27\,n^2}{(2_n-1)^2\,(n+1)} \cdot \frac{\left(\frac{L}{x_m}\right)^{2n}}{\left[\left(\frac{L}{x_m}\right)^2 + \frac{n+1}{2\,n-1}\right]^2} \qquad (7)$$

which formula permits the determination of the value of $\frac{L}{X_m}$ but only verifying tentatively different values that serve to identify it and not directly, which is perhaps inconvenient, but not important.

Having obtained X_m, the solution is attained: In fact, as already observed, this consists in finding n, which is given from (3); of a, which is given from (4) by means of the value now obtained for x_m, and finally in knowing b, which is deduced by means of a from (1) that is

$$b = \frac{V\,(L^n + a)}{L^n}$$

The proof of the applicability of the formulæ by means of the comparison with the experimental data is convincing; also it is not necessary to know with great accuracy the value of n.

With the data furnished by the same author, we also find that in order to obtain a great degree of accuracy, we may (and should) apply another group of formulæ deduced from the preceding ones and from the following

$$dt = \frac{dx}{v}$$

or from its integral

$$t = \frac{1}{b}\left[x + \frac{a\,x^{1-n}}{1-n}\right]$$

But we believe it useless to report and discuss these last formulæ, since to apply them practically, it is not sufficient to know the data that we have shown above, but it is necessary to know also the results of the measures of the accelerimeter, the adoption of which is becoming general since its perfection recently.

Now we note that the new forms of the accelerimeter (Cranz, Wollf, &c., &c.) are nicely adapted to measurements on rifles and on arms of small calibers, but that, at present the models constructed for measurements on large cannon have not given the same practical results; meanwhile the questions of the loading of large cannon and therefore the application and the experiment with the new formulæ for determining these are proving most interesting to naval artillerists. —*Rivista Marittima*, February, 1911.

✦ ✦ ✦

THE DEFENSE OF THE LAND FRONT OF A COAST FORTRESS, WITH PARTICULAR REFERENCE TO THE METHOD OF UTILISING THE MOBILE GUNS ALLOTTED TO GENERAL DEFENSE

By Lt.-Col. H. de T. Phillips, R.G.A.

(Extract)

During recent years a largely increased interest has been shown by Coast Defense Commanders and R.G.A. officers of all ranks in the important subject of the efficient utilisation of the mobile guns and howitzers allotted to the armaments of Coast Defense Commands and in the subject of defense by land fronts generally.

The fact that at home stations, this portion of the defense was previously almost entirely in the hands of what was then the Militia and that a very limited amount of ammunition was available for practice from these guns by the regulars, dulled the interest of the coast companies of the R.G.A. in this portion of their work, but a stimulus in this direction was created, to a great extent probably, by the experiences of R.G.A. officers in South Africa with batteries of "cow guns", and subsequently by the most notable example of modern times of the attack and defense of a coast fortress—that of Port Arthur.

The demonstration, under the most modern and up-to-date conditions of what has practically been accepted as a maxim, viz., that a coast fortress cannot be efficiently attacked or defended from the sea alone, has evoked much thought and interest in the matter among soldiers in general and gunners in particular. Several books and articles have been written showing the connection between command of the sea, and the necessities and possibilities of attack and defense of coast fortresses, and the broad principles laid down therein will not be repeated here—nor is it intended in this article, to enter deeply into the question of whether the landward perimeter of the fortress is best defended by permanent works or by a chain of earthworks of the field type, but it may be taken as a general condition of our own land defenses that permanent works are not provided.

Whether this state of things is the result of necessary economy or part of a carefully thought out and deliberately laid down scheme of organisation does not much affect the matter.

We must deal with conditions as they exist.

The doubtful utility of permanent works on land fronts has frequently been pointed out, and the balance of expert opinion in England appears to be against them.

In considering, however, the most necessary factors affecting the preparation of the artillery defenses it will, I think, appear that what are generally known as permanent works show very few points in which they are superior to earthworks. The principal requisites may be considered under the following general headings:—

1. Concealment and invulnerability.
2. Secrecy as regards distribution, etc.
3. Mobility.
4. Utilisation of the advantage conferred by a long period of preparation.

1. CONCEALMENT AND INVULNERABILITY

This is best obtained by a study of the ground and by siting guns in earthworks constructed so as to conform with natural features and generally made to blend with the landscape. The emplacements should be of as little depth as possible and sited so as to be apart from the lines of infantry trench which would be similarly constructed. The judicious planting of trees and shrubs in peace time will do much towards rendering concealment possible and in many cases they may be so planted as to afford cover to movements of troops or guns within the defenders lines. A thin screen of trees will often make guns difficult to locate without in any way interfering with their effective fire. It may be noted that the Russian permanent works at Port Arthur suffered much from being conspicuous as objectives, having great depth which made them easy to hit and forming veritable shell traps.

They were very solidly constructed of masonry and concrete but, being exactly located by the enemy, it was only a matter of time, bringing up of sufficiently heavy artillery and eventually sapping to effect their reduction.

An inspection of the works after the siege brought home to one very vividly the enormously destructive effects of a concentrated bombardment of heavy artillery.

The difficulty of capturing a position fortified by practically nothing but earthworks is well exemplified by the attack, during the same siege, of 203 Metre Hill.

This position was in a portion of the perimeter whose defenses had not been constructed previous to the siege. Emplacements had been prepared for the guns but these were destroyed and the guns dismounted by the Japanese. The tremendous struggle and enormous sacrifice of life entailed in the capture of the lines of earth trenches is too well known to require comment.

Had 203 Metre Hill been constructed with good communications and flanking defense from the rest of the perimeter, its capture would have been very much more difficult.

There appears to be a concensus of opinion against the employment of large permanent works for land fronts though some people still pin their faith to the mounting of guns in small steel cupolas.

These latter can no doubt be made very inconspicuous and invulnerable but are expensive to erect and, once erected, fix the gun defense to certain spots which must eventually be located by the attackers.

It would seem that the most economical, certainly, and probably the most efficient method of securing invulnerability is to have a defensive line consisting of earth trenches of little depth from front to rear, with well concealed gun emplacements of earth where necessary.

Supports and reserves and reserve artillery ammunition would be in well concealed positions in easy communication with the defensive line.

In the case of the possession of a ceinture railway, much of the artillery ammunition could remain in trucks in covered positions and could be easily moved with the guns on a change of position.

This would give the defenders an advantage over the attackers which can readily be grasped and of which a practical demonstration was afforded at Port Arthur in miles of tramway which had to be laid by the Japanese up hill and down dale in order to keep their batteries supplied with ammunition necessitating an enormous number of men being employed to run the shell trucks on the tramways.

2. SECRECY

Secrecy as regards distribution and organisation of the defenses may be obtained by not actually constructing the works of defense but having the plans of all proposed works and their sites approved for immediate construction on mobilisation, but, as this method involves a large element of danger of unpreparedness, it would probably be better to prepare a very much larger number of emplacements in peace time than are actually required for the number of guns allotted to the defense, thus creating at any rate a false impression in the mind of the inquiring spy as to the destribution of guns, etc. I have heard it given as a reason for not constructing land defenses in peace time that the ground is generally accessible to possible spies, who could prepare maps of the defenses. It would surely be of as much value to a possible enemy to know that there were no preparations whatever for defending a position.

In the United Kingdom no doubt a large amount of civilian labor could be procured on mobilisation to assist in carrying out previously elaborated plans of defense but there are places within the Empire where the amount of civilian labor likely to be procurable on the outbreak of hostilities would be a very problematical factor.

The question of denial of access to areas defended or allotted to land defenses will be often a difficult one to deal with in peace time and is out of the scope of the present article.

3. MOBILITY

Mobility is perhaps the most important of all the requisites in the defense. It is of course only a comparative term, not necessarily implying power of moving with great rapidity but having a facility of movement superior generally to that of an enemy, who would not have the advantage of attacking from a previously prepared position.

It is to be attained partially by having a proportion of light field or mountain guns capable of accompanying a counter-attack or rapidly reinforcing a threatened point. Such pieces would as a rule be allotted to the general or local reserves.

As regards the heavier natures of guns of the general defense, however, they may be said to be mobile if they can be shifted from one position to another by means of previously constructed communications more rapidly than the guns of the enemy which will for a time be entirely dependent on such roads as may be found existing in the country and which may be of no great assistance to them. Even guns which can be withdrawn during the night and be ready to open fire from a new position at daybreak will often seriously upset the attacker's plans. This superior power of movement can only be obtained by preparations made in peace time. It is of no use to postpone the construction of roads and communications until hostilities are imminent, as roads, especially those required for heavy gun traffic, take time to become properly consolidated and take a long time to make. The Russians fully grasped the necessity of good communications at Port Arthur, where it would have been possible to drive a coach up the roads connecting the forts with each other, and the town and docks in rear, except in the case of 203-Metre Hill, the preparation of which for defense had not been made before the siege. The roads should consist of well defiladed lateral communications as well as a radial system from the area to be defended, and there should be good roads leading right into the gun emplacements.

The question of roads in front of the defended position has to be weighed on the spot in each case. In some cases they will facilitate counter-attack, in others they may be a source of danger and would be better non-existent. In all cases however, they should be as few as possible.

Roads affording good lateral communications in the enemy's position are a disadvantage to the defense but the existence of certain well defined roads leading from the enemy's position have their advantages in rendering easier the arrangement of examining guards, etc., and in some cases restricting the possible lines of advance especially by night. A point in connection with this was forcibly brought home to the writer not long ago in the case of a wild mountainous tract of country in which twelve years ago no roads of any value were existent but a large number of village footpaths and tracks converging for the most part on to the passes through the mountains forming the defensive position. By degrees a few roads of better class were made taking definite lines through these passes. It was found that the increased convenience of travelling given by these few roads seemed to make the inhabitants use them almost entirely, even when it necessitated a somewhat longer journey, with the consequence that many of the previously existing tracks became overgrown and obliterated by disuse. The vegetation was only the sort of low scrub which finds an existence on the rocky soil, yet, after a couple of years disuse, a footpath which was once rideable could only be found, if at all, with the greatest difficulty by daylight, on foot.

In many cases, especially with a large defensive perimeter and no very great natural obstacles, it is probable that a most effective way of obtaining mobility within the defenses of an important fortress would be to construct a ceinture railway, which would have sidings, wherever possible, running into each heavy gun emplacement.

This would not only provide for the actual rapid transport of guns, men and stores to any point by day or night but would, in suitable cases, admit of the employment of heavy guns and howitzers mounted on and fired from special trucks—a method which would be of great assistance where the garrison and number of guns were somewhat small for the perimeter. It might often be possible to construct the railway line so as to have sections of it constructed without gradient between, say, alternative gun emplacements so as to facilitate the man-handling of the trucks when other means of traction were not at hand.

There is little doubt that good, well laid out roads constitute the most important feature of defensive preparation.

This principle was carried out in 1886 when it was decided to construct a large entrenched camp at Quetta. The first work undertaken was the construction of miles of good macadamised roads to facilitate the passage of artillery to positions in the defensive line.

4. UTILISATION OF THE ADVANTAGES CONFERRED BY A LONG PERIOD OF PREPARATION

The previous headings in this paper have of course dealt essentially with matters which come under this heading but what I now propose to discuss is the preparations which can be made by officers and units themselves in contradistinction to the preparations which are the outcome of a policy and involve large expenditure of public funds.

First and foremost it is necessary to take advantage in every way of the possession of local knowledge.

A thorough and intimate acquaintance with the terrain and the possession of really good maps is the first essential for utilising this advantage.

Not only should every defensive position be known but also every point favorable or otherwise to the attacker—his main lines of advance—positions to which he could move light artillery and those to which alone heavy guns could be transported—and this knowledge can best be obtained by carrying out on the ground Regimental and Staff Tours, and better still by actually encamping units for considerable periods in the year on the ground itself. This can be done by utilising periods of Field Training and, in some places abroad, artillery practice camps for the purpose. As an instance of this, I may mention that in two successive movable armament practice camps (in two successive years) at Hong Kong, the batteries first carried out the defense of a portion of the position and in the next year the attack of the same. Officers and men by this means became familiar with every hill, valley, village, and watercourse and in the case of the attacking camp everything was conveyed by water to the place of disembarkation including the guns and ammunition. In England this could only be done by means of a staff tour but such tour would be more valuable if it were possible to devote a couple of weeks to it instead of a couple of days.

The primary necessity for obtaining local knowledge and applying it is the possession of reliably accurate maps and no work spent on them in peace time to ensure their reliability is thrown away.

General maps on a scale of about two inches to one mile, should be carefully contoured at 50 foot intervals while maps on about twice this scale should be issued for artillery purposes and contoured to proportionately smaller intervals.

It is believed that maps for this purpose are now being prepared in some cases in the United Kingdom on a scale of three inches to one mile. All maps should be squared on the method adopted in the case of sea areas in charts used for Coast Defense.

Some little time ago, an article appeared in the *R. A. Journal** (by Major Buckle), advocating the use of squared maps in this connection and suggesting a method of using them.

The only fault I had to find with his suggestion is that for general purposes the sides of his squares were too large. They might be suitable for a civilised, densely populated country, where there is an infinity of detail for identification of points in each square, but, for wild thinly inhabited countries the squares should be smaller, as notable detail is often confined to the shape and position of a rock or tree of which there may be many varying but little in size shape and colour. For this reason it seems desirable to reduce the size of the square. As a matter of fact some time previous to the appearance of the article referred to, the land maps at Hong Kong, had been prepared with squares of 400 yards side in continuation of the squares in use over the sea area.

These were utilised by all arms and gave good results practically—in fact it became easier, in a country of difficult and out-landish names, to identify points in the country as village in "Mess 53" than as, say, "Kau Lung Tsai," especially if there happened to be more than one village rejoicing in the same name.

The idea of squaring land areas is by no means new and a division of the ground—not actually into squares but into portions of sectors radiating from a battery of siege guns was used at Lydd twenty years ago.

There has been a great "boom" in panoramic sketches in recent years and they undoubtedly have a great value when the user can rely on adopting the same point of view as the sketcher. Their drawback is that an officer finding himself in possession of a large number of panoramic sketches, of varying merit, taken from a great many different points of view will find the collation of the same so as to give a clear idea of the country a matter of great difficulty. As records however in definitely fixed artillery or observation positions they have great value, especially if prepared with correct orientation of the points shown in the sketch.

In the use of maps in the preparation for artillery defense great importance attaches to the accuracy of the contouring for reasons which it is now proposed to explain.

In the article on the use of squares over land areas, already alluded to, mention is made of undulating country but no easy method is suggested of engaging invisible targets above or below the gun.

The possession of accurately contoured maps permits the use in conjunction with them of an adjunct to the map which may be described as a graphic Range Table or Chart of Trajectories for any nature of gun employed. This chart, prepared in peace time, can be utilised in controlling and ranging the guns of the defense as well as in rapidly solving a large number of problems which present themselves in engaging objectives, selecting appropriate sites for gun positions, etc.

---

* "Fighting Guns Landwards," by Maj. C. R. Buckle, D.S.O., R.G.A. *Journal of the Royal Artillery*, Vol. XXXIV., No. 5, August, 1907.

The chart consists essentially of a diagram of trajectories of any one nature of gun plotted in such a way as to show at a glance the height of the trajectory corresponding to a certain elevation at any point up to the extreme range of the gun, and of height lines and angles of sight enabling targets visible or otherwise to be engaged on ground at any height above or below the guns. The chart will be best understood by reading the directions for its construction. Its construction involves considerable initial labor, but, once made out for any nature of gun, it is available for use with any gun of that nature in any part of the world, provided that the total height shown above and below the point of origin of the trajectories covers the probable differences of height between the gun and target in any case which may arise in the locality in which it is used.

Directions for the Construction of a Chart of Trajectories

1. The trajectories shown on the chart should be those for a series of successive elevations such that the number of minutes difference in elevation between two adjacent trajectories corresponds to range difference of less than twice the 50 per cent. length zone of the gun at that elevation. (Vide diagram B, opposite page 322.)

e.g. For the 15-pounder B.L. gun. At 1000 yards twice the 50 per cent. zone = 38 yards, 5 minutes elevation alters range by 59 yards.

Therefore interval between trajectories at 1000 yards should be 3, or say, 2½ minutes.

But as the interval between any two trajectories may easily be divided by eye, 5 minute intervals will be sufficiently small. At 4000 yards for same gun 50 per cent. zone × 2 = 92 yards, 5 minutes alters range by 26 yards.

Therefore on above principle 30 minutes is a small enough interval for trajectories.

2. Interval being fixed upon—a scale for chart capable of showing the required differences can be decided on (probably 200 yards to 1 inch will be generally suitable).

3. Decide the maximum number of feet above or below the gun that any target to be engaged may be situated.

The feet above, + the feet below, fixes the height of the chart—the maximum range at a given scale fixes the width of it. It will, however, in order to obtain clear readings, be necessary to exaggerate the vertical scale.* It will generally be at least six times the horizontal scale.

4. Let X Y be the vertical height of your chart. Take a point G in the left edge such as G X = to scale, the greatest possible height of target above gun, and G Y = the greatest possible below.

From G draw a horizontal line of ranges G Z = to maximum range of gun.

5. Mark off along G Z ranges from the range table corresponding to elevation at which you desire to draw trajectories (i.e. at intervals of 5, 10, or any other number of minutes) and mark the elevations above the ranges.

6. Through these elevation points draw vertical lines across the paper parallel to X Y.

---

* In the case of howitzers such exaggeration of the vertical scale may not be necessary. This would enable a much simplified form of chart to be used and this will be dealt with later on.

U OF M

7. Parallel to G Z draw horizontal lines representing at the exaggerated vertical scale heights above or below gun at any convenient interval.

8. Select any convenient elevation line (vide 6) and mark off on it above and below G Z distances corresponding to the number of feet subtended at the range due to that elevation by the number of minutes difference required between the trajectories (using vertical scale) e.g. 5 minutes gives 25 feet at 6000 yards.

9. Draw rays from G through the various points on the 6000 (or other selected) elevation line.

These rays represent angles of sight and will give the vertical height due to them at any range.

10. The points where the rays cut each elevation line (para. 6) represent elevations above or below G Z differing successively by so many minutes.

By joining all points corresponding to the same elevation curves will be formed representing successive trajectories of the gun and the points where the curves cut the horizontal height lines (para. 7), show the actual height of the trajectories at those points.

11. It will be found convenient, to obviate confusion in inking in, to ink in the trajectories and the horizontal height lines only—rubbing out the remainder—though additional facility in use is given if the vertical elevation lines are inked in in very fine lines. Angles of sight should be marked on the margins.

Figure the chart as may be convenient. It is of some assistance to put a light wash of red between the trajectory at each whole degree and the next trajectory above it.

The diagram attached (A)* is from a photograph of a Graphic Range Table for a 4.7 Q.F. gun, and a smaller diagram (B) shows (for a 12-pounder Q. F.) the method of construction as described above.†

In this method draw vertical range lines (i.e. through the yard divisions on G Z) and up and down each range line plot the vertical distances subtended by the number of minutes difference in trajectories (5′, 10′, or other intervals) and join corresponding elevations as before.

There is less drawing in this latter method but more calculation and it must be remembered that the vertical intervals will not necessarily always start from G Z if you wish to read elevations in multiples of 5 minutes, 10 minutes, etc. e.g. 15-pounder B. L. Range 3000 yards—elevation = 5 degrees 24 minutes.

Here, in plotting the intervals for 5 minutes up and down the 3000 yards line, the first interval will be above the line only ⅕th of the interval due to 5 minutes at 3000 yards and ⅘ths below it (marking elevations 5° 25′ and 5° 20′ respectively).

An enormous variety of problems can be solved at once from the chart without any calculation and a few specimen examples solved from a 4.7 Q.F. chart are appended.

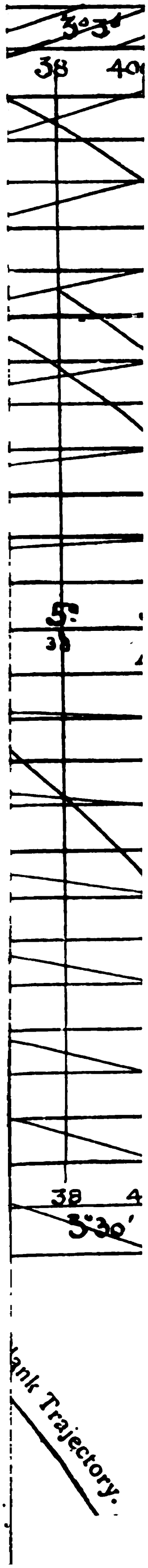
* * * * * * * *

Charts when constructed should be mounted on linen and pinned down to a board. A pivoted range arm is of assistance sometimes but most solutions can be arrived at with the aid of a few glass headed pins and a piece of string.

---

* Not reproduced in *Journal U. S. Artillery.*

† Should a long ruler be available for drawing the rays, the above is the most convenient way of constructing the chart. It is possible, however, to construct the chart without drawing the rays.



5°
3°30′
nk Trajectory.

It might be preferable to have the chart engraved on xylonite and glued to a board, but, though more durable, it would not be quite so easy to use as one into which pins can be stuck to mark points. A pencil mark is not so obvious as a pin, and is more likely to lead to error.

* * * * * * * *

Having roughly sited all the emplacements, including alternative ones and the best observing stations, the exact sites are easily fixed by going on to the ground. Emplacements may then be made or platforms laid. If this is impossible under peace conditions the exact sites should be noted and marked.

The next thing is to mark out the dead ground carefully on a map for each gun position. This may appear to be a very arduous task, and so it is for one man, but with three men working together it is done much more quickly.

One has a map and notes the obstructive contours on each bearing used and calls out their height above the gun and range to another man working on the chart. This latter calls out the range and height at which trajectory meets further slope to a third man writing—or the map man can mark them in on the map. The dead ground having been fixed they proceed to ascertain and record in a book, prepared with suitable columns, the exact quadrant elevation and lateral angle from specified aiming point required to hit the center of each square. A suitable length of fuze may also be noted.

A good method of placing the names of squares on the map without obliterating detail, is to form the letters with a light wash of Indian ink in block capitals two or three squares high.

They are put in otherwise on the specimen map* in order to permit of more easy reproduction. Dead ground is also better indicated by a wash of some light transparent color, but the absence of certain squares from the fighting book of the gun will indicate dead ground without showing it on the map.

In order to assist in siting guns for flanking fire, dead ground in front of guns, due to insufficient depression should also be ascertained and noted.

CHARTS FOR HOWITZERS

In the case of guns, the necessary exaggeration of the vertical interval distorts the trajectory and each must be drawn in. (Vide diagram D.)*

In the case of howitzers, however, the making of a chart is simplified as heights may be made to same as horizontal scale. The complete trajectory of the howitzer is then drawn and mounted on xylonite or metal (preferably transparent xylonite). The various trajectories are ascertained by pivoting the full trajectory at its point of origin to the point of origin of the chart, which need only be marked with height lines and angles of sight. (Vide diagram D.)*

A very convenient way in the case of a howitzer is to use a transparent sector of which the apex angle is equal to the tangent angle of elevation for the furthest range. It is pivoted at the apex, so that when one edge of the sector is on the horizontal line of ranges on the chart, the other (upper) edge is a tangent to the trajectory at the muzzle. The actual trajectory is engraved on the sector, the range table elevations and ranges being marked at their proper positions along the trajectory. To find the Q. E. to hit any point—

---

* Not reproduced.

mark the point at the correct contour and range on the chart—move the sector until some point on the trajectory passes through the marked point.

The upper edge of the sector will then mark the required Q. E. on the angle of sight scale which is marked on the chart.

A separate sector would be advisable for each charge, though all the trajectories might be engraved on one sector. The latter method would, however, lead to confusion, but would have the advantage of showing at a glance which charge was most suitable for any target.

The fact of using the same vertical and horizontal scale in the case of the howitzer enables the chart to be much smaller, and with a separate trajectory for each nature of howitzer and for each charge, one chart board will suffice for solving all the problems.

When, with the aid of the charts described, we have sited our guns, marked out arcs of fire and dead ground, and tabulated the quadrant elevations for each square on the map, we shall have done a very great deal towards the artillery organisation of the defense in points not requiring large expenditure of public funds.

In natural sequence the construction of roads to and between emplacements would come next but here large expenditure of money comes in and so this point is omitted in this section.

The positions of stations for fire control and observation posts will have been decided in connection with siting the guns.

The communications between all these points and the guns should be primarily telephonic but alternative signalling communication should be arranged for. In the case of the latter, stations out of sight of the enemy must be carefully selected and given code names—care being taken that, as these names will also be employed on the telephone, there shall be no risk of confusion through similarity of sound. Semaphore with flags of different distinguishing colors should be used as far as possible for battery observation of fire, using morse for control and inter-communication between units.

The actual installation of permanent telephone cables from point-to-point again involves large expenditure but, in many cases, before such cost was sanctioned, it would be possible to run a couple of aerial wires through all emplacements and control stations, to which field telephones could be linked up as required. These two lines should be independent of all lines installed for general fortress purposes. In peace time, owing to private rights, this is only likely to be possible at stations abroad. Peace training at home must be carried out by flag signalling. As a matter of fact, as far as sending in observations in code is concerned, signalling is far more rapid and reliable. On one occasion a coast battery was being ranged at a concealed target from a position about three miles from the battery, and though telephones were available, they were quickly discarded in favor of the helio.

The question of the utilisation of coast defense guns to assist the defense landwards has, I know, many opponents and there are some cases in which they would be unable to assist and others in which it would be unnecessary.

When one considers, however, that the guns in question, being provided with oriented arcs and having absolutely fixed pivots, are peculiarly adapted to being usefully employed over land areas, it is a pity not to make arrangements in peace time to admit of such employment when advisable. The fact of increasing their possible rôle does not in any way imply that their primary rôle is to be neglected either in organisation or training. There would be no work for them to do seawards and then it would surely be better to add their weight of metal to that of the land front than to leave them idle. The life of the gun of course has to be considered but the decision of what method of employment gives the preponderance of advantage could be left to those on the spot.

Shrapnel would probably be the best projectile to employ with them.

Owing to their retired position from the general line they could often search out areas that are dead to the mobile guns in the first line.

It may be expecting a great deal of the garrison gunner to devote the time that is here suggested to the land defense, and the factor that is most frightening is that of moving heavy guns up into position for drill purposes. This latter, however, is not at all necessary.

Nowhere are the dummy tripod guns used for teaching laying and fire discipline, more useful than as a substitute for heavy guns which it is often impossible to move into position in the time available.

Nearly all the training can be carried out with these tripods, with if necessary, skeleton detachments.

Many other methods by which preparations can be made for artillery land defense will no doubt suggest themselves to officers who have studied the subject. I have only named one or two and my excuse for describing them at such length is that, without great labor, they enable so much to be done with available material and definitely settle questions of artillery defense which are often only too vaguely thought out.

To sum up, the requirements for the preparation of the land defense of a coast fortress, dealt with in this article, are as follows:—

1. Provide reliable contoured and squared maps.

2. Study them with a view to the enemy's possible and probable line of attack.

3. Fix your own defensive line (and generally a second line as well) with a view of:—

a. Keeping the enemy's artillery beyond shelling range of the object you are defending.

b. Avoiding exposure of your own guns to his view.

c. Giving your own guns as great a degree of mobility as possible (e.g. alternative positions).

d. Siting guns, etc., so that in the event of retirement to a second line, your positions in first line are of no use to enemy.

e. In mountainous country arranging, as will often be possible, to have a hill or ridge between you and the town to act as a stop butt to shells going over your first line.

(At Port Arthur the hills behind the Russian Forts looked as if the slopes had been prepared for afforestation on an extensive scale so numerous were the craters made by misses from Japanese guns.)

4. Make your radial and communicating roads throughout your positions.

5. Make your emplacements and trenches or at any rate carefully mark positions of guns, observation posts, etc.

6. Prepare your maps as suggested in this article, and make records of information both for mobile and coast guns.

7. Install your system of telephonic communication between the Fortress Commander and the sections.

8. Instal purely artillery telephones.

For the rest, some pieces of water piping iron standards, or short lengths of wood to form the pivot, and a little wire are all the stores required.

Capt. Mance mentions that at the Siege of Mafeking the defenders employed a very serviceable type of loophole—an iron plate about 3′ x 1′ 3″ x ½″ thick bent at right angles with a small rectangular hole at the angle (Fig. 2).

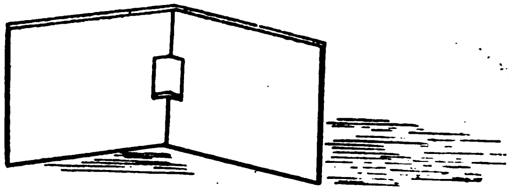


FIG. 2.

One of these plates was struck by 26 bullets! With this type of loophole, however, the defender, if of a mathematical turn of mind, will be wondering all the time what the chances are of a bullet finding its way through the rectangular hole and thence to its billet. The nervous wear and tear of the survivor of the 26 hits must have been prodigious. No such problem harasses our defender of the "perfect" loophole. The pattering of bullets on the plate will be as music to his soul for he is buoyed by the certain knowledge that in the long run it is a case of "Heads I win, tails you lose," and as he draws his bead for the last time upon the foe he softly murmurs "He laughs best who laughs last." –*The Royal Engineers Journal*, April, 1911.

✦ ✦ ✦

MODERN MILITARY RIFLES

I.

(Extract)

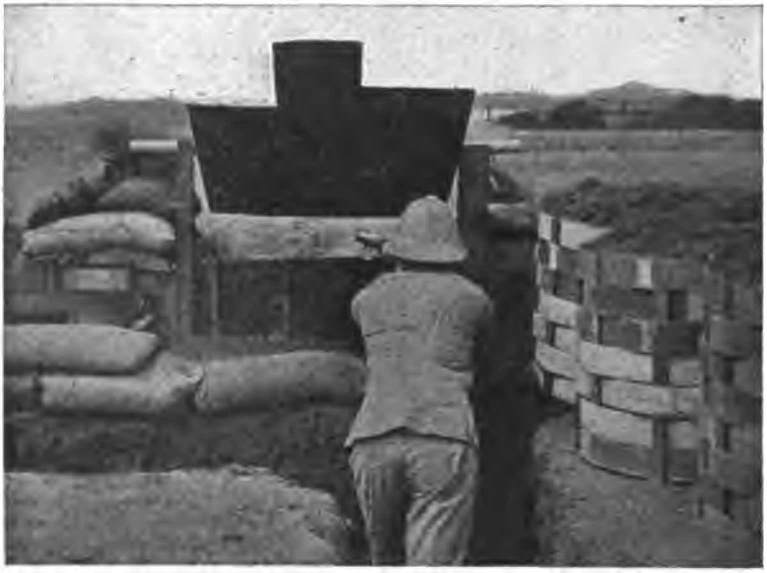
I propose in the following article to describe briefly the present weapons used by the Great Powers of the world, to compare them with the weapons in use 20 years ago, and to forecast as far as possible the great advance in rifle manufacture. Let us first summarize the chief alterations that have occurred in the last 20 years. We shall find as we progress that the rifles have become lighter and shorter, that the caliber has become smaller, the range greater. To a great extent all these changes have been due to the introduction of the nitro-cellulose or other smokeless powders and the small bullet.

CALIBER

The caliber of a rifle is the diameter of the bore measured across the lands —*i.e.*, the portion of the bore left by the instrument when cutting out the grooves. The subjoined table gives a summary of the calibers at the present day and about the year 1885:—

The Royal Engineers Journal.

PHOTO A



The Royal Engineers Journal.

PHOTO B

	1909.		1885.	
	Rifle.	Caliber.	Rifle.	Caliber.
		inches.		inches.
Austria	Mannlicher	.315	Werndl	.433
Belgium	Mauser	.301	Albini-Braendlin	.433
Denmark	Krag-Jorgensen	.315	Remington	.433
France	Lebel	.315	Gras	.433
Germany	Mauser	.311	Mauser	.433
Great Britain	M.-L.-Enfield	.303	Martini-Henry	.450
Great Britain	S. M. L. E.	.303	——	——
Italy	Mannlicher Carc'o	.256	Vetterli	.409
Japan	30th Year	.256	——	——
Russia	3-Line	.300	Berdan	.420
Switzerland	Schmidt-Rubin	.295	Vetterli	.409
United States	Krag-Jorgensen	.300	(Long) Springfi'd	.450
United States	(Short) Springfi'd	.300	——	——

The weights and lengths of these same rifles are as follows:—

1905.

	Rifle.	Weight.		Length.
		lbs.	ozs.	inches.
Austria	Mannlicher	8	5½	50.00
Belgium	Mauser	8	9½	50.25
Denmark	Krag-Jorgensen	9	11¾	52.75
France	Lebel	9	3½	51.12
Germany	Mauser	9	0	49.40
Great Britain	M.-Lee-Enfield	9	4	49.50
Italy	Mannlicher-Carcano	8	6½	50.75
Japan	30th-Year	8	9½	50.50
Great Britain	Short M. L. E.	8	2½	44.50
Russia	3-Line	8	15¼	51.87
Switzerland	(Short) Schmidt-Rubin	8	0½	43.12
United States	Krag-Jorgensen	9	1	49.25
United States	(Short) Springfield	9	2	43.25

1885.

	Rifle.	Weight.		Length.
		lbs.	ozs.	inches.
Austria	Werndl	9	13½	50.00
Belgium	Albini-Braendlin	9	14	53.50
Denmark	Remington	9	5½	50.25
France	Gras	9	11	51.25
Germany	Mauser	10	2½	52.75
Great Britain	Martini-Henry	9	0	49.50
Italy	Vetterli	9	13¾	54.00
Russia	Berdan	9	12½	53.00
Switzerland	Vetterli	10	2¼	52.00
United States	(Long) Springfield	9	5¼	51.75

The above tables show that the tendency has been to reduce the rifle in length and weight. By reducing the length reduction in weight followed as a matter of course, unless the thickness of the barrel was increased. The improvement in the barrel, the powder charge, and the bullet has enabled the accuracy and rapidity of fire of the rifle to be greatly augmented, with a decreased likelihood of the enemy coming to close quarters. The bayonet, therefore, has ceased to be such an important factor as in the old days, when cavalry charges were awaited in square with the infantry in two ranks—the rifle was used as a species of pike and the muzzles of the rear rank had as a precaution of safety to be well clear of the faces of the front rank. We will discuss bayonets a little later on. With a more powerful and slower burning propellant the barrel can be gauged as to length to a nicety, the *desideratum* being that the last grain of powder shall be converted into gas as the bullet leaves the muzzle. Sufficient pressure must be kept up on the base of the bullet during its flight down the bore to ensure a high initial velocity, but a residue of unburnt powder will result in inconvenience to the firer in a head wind, whilst an unnecessarily long barrel will cause loss of speed owing to increased friction. Too short a barrel will result in unsteady flight and diminished initial velocity. It is these factors which determine the length of the barrel. The above considerations permitted a reduction in the length of the rifle, and consequently a considerable saving in the weight. From a foot soldier's point of view this is of paramount importance, as every ounce saved in the arm means more ammunition and less fatigue. That some limit must be placed on the reduction of weight is patent, for the rifle in the hands of a soldier differs considerably from that in the hands of a sportsman. Accuracy with great punishing power at short ranges are the *desiderata* of the latter. Strength to withstand the wear and tear of active service, the shock of the bayonet thrust and parry, together with accuracy and a flat trajectory up to 1,000 yards at least, without undue recoil, are the essential points of the former. The sportsman employs a gillie or shikari to carry his gun, and it is more or less immaterial to him whether his gun is lighter or heavier by a few ounces. The question of the recoil, too, is not such an important one. The few rounds fired by a big game shot in a day or even a week will not cause him inconvenience, but a modern battle lasts some days or weeks, and the soldier may be called on to fire some 200 to 300 rounds daily. The recoil, therefore, must be kept down within reasonable limits. We may assume that a military rifle (non-automatic) should weigh between 8 lb. and 9 lb. If this weight is still further decreased, two objections will arise; either the barrel and breech will be too weak to withstand the shock of discharge or the "kick" of the rifle will be excessive. The energy of recoil should be under 15 lb., the caliber between .256 in. and .315 in.; the breech action should be capable of delivering, if desired, between 20 and 30 aimed shots in a minute. The explosive must be safe to handle, stand heat and cold, be powerful and not too rapid in its action, or it will destroy the barrel and breech. The bullet must keep up to its speed, be hard enough to withstand the force of the explosion, and yet soft enough to be expanded into the grooves; it must also be of such a nature that on impact it breaks up sufficiently to place the foe *hors de combat* without being classified as inhuman.

* * * * * * * *

—*The Army and Navy Gazette*, January 21, 1911.

IV.

AUTOMATIC RIFLES

Every nation has been experimenting of late years with automatic rifles and pistols. The latter weapons are now on the market, and the .44 caliber, Browning's automatic pistol, leaves little to be desired. It works well, is handy and accurate, and takes the Service cartridge. A pistol is required for offense and defense at close quarters, and it is essential that it should be of such a caliber as to stop a man who desires to come on.

The question of an automatic rifle is a more complicated one, as the difficulties to be faced are greater. The chief are:—(1) The enormous power of the explosive gases; (2) the weight of the parts that must of necessity be operated on by the recoil. The *desiderata* are:—(1) Simplicity; (2) strength; (3) facility of repair; (4) non-liability to jamb or get out of order; (5) capability of being used as an ordinary rifle should the automatic action break down; (6) good ejection.

Automatic rifles are dependent for their action on one of two forces:—(1) The explosive force of the powder gas; (2) the force of recoil. The latter method appears to be the most usually adopted, and is the one that gives the greatest likelihood of success. In the first method a small hole is bored in the barrel near the muzzle, and the gas is allowed to pass into this hole after the bullet has proceeded up the bore. This very much condensed gas acts on a piston working in a cylinder and connected by a long rod to the bolt or breech block which it forces back against a spring. The breech block or bolt in its passage to the rear draws the cartridge case out of the chamber and ejects it. A fresh cartridge is fed up into the bolt way, and the recoil spring which has been compressed by the backward movement of the bolt or block reasserts itself and drives the cartridge into the chamber. This is termed automatic "feed." The advantages of a gas operated system are that —(1) By an adjusting screw the amount of gas can be regulated, and thus extra power can be acquired to overcome increased friction. (2) The barrel does not move. The disadvantages are:—(1) Long rods are required to connect the piston with the block or bolt. These are either buried in the stock, which they tend to weaken, or are fixed outside the rifle, forming unsightly and unsatisfactory projections. (2) The escaping gases are apt to char and corrode the wood or metal of the rifle.

The action of recoil operated rifles is as follows:—The force of the recoil drives back the barrel an inch or so at a great rate, carrying the bolt or breech block with it. The barrel now stops and is carried forward again by the barrel recoil spring. The block or bolt is carried still further to the rear owing to the impetus imparted to it by the barrel, and the case is ejected and a fresh cartridge fed up into the bolt way. The bolt or breech is now forced forward by the recoil spring asserting itself, and the cartridge is fed into the chamber. Like gas-operated rifles, some worked by recoil are only automatic "feed," and some are automatic "feed and fire." The advantages of the system are that—(1) They are neater, having no connecting-rods; (2) There is no charring or corrosion. Their disadvantages are—(1) There is no reserve force to overcome friction caused by extraneous matter getting into the bearings; (2) The barrel moves during the passage of the bullet down the barrel.

Automatic rifles can only be considered in an experimental stage at present. All nations profess to have one at hand, but are chary of incurring the enormous expense that their introduction would entail.

The advantages of automatic rifles may be summed up as follows:—(1) Rapidity of fire—so long as cartridges remain in the magazine, fire can be sustained at a great rate. (2) Immobility on the part of the firer during the same period. (3) Saving of labor and fatigue; the rifle can be kept steadily pressed into the shoulder. (4) Less recoil; a considerable quantity of the force of the recoil is taken up in compressing the recoil springs and working the automatic action. Their disadvantages in their present state are:—(1) Uncertainty of action. (2) Inability to withstand dust or dirt in the action. (3) Faulty ejection; the cartridges have no time to cool before they are ejected; in some patterns these are ejected in such a way as to strike the firer or his next door neighbor, as they are projected with great force and at great heat; this might cause great inconvenience if not serious injury. (4) Complicated mechanism, which cannot withstand the wear and tear of service.

There are other general disadvantages in the introduction of such a system, which may be summed up as follows:—(1) Increased cost of armament; (2) increased training, the time for which can be ill-spared; (3) increased ammunition supply. (1) Is more a matter for the taxpayer than anyone else. As regards (2), the present short service system and the prevalent idea that a soldier must be a jack of all trades, combining the mechanical precision necessary for a ceremonial parade with the woodcraft and tracking ability of a backwoodsman, or the climbing abilities and keen vision of a Kashmir Shikari, does not induce one to welcome the introduction of a more complicated weapon that will require more time to teach and more individual attention and care bestowed on it on the part of the soldier. (3) It cannot be imagined that everybody—good, bad, or indifferent shot as he may be—will be armed with an automatic rifle capable of firing 40 rounds a minute, perchance into the void. To keep up the ammunition supply in action with the present rifles is a difficult task that taxes the brains of all armies. How much more so if the troops are armed in any quantities with automatic rifles? The most a man can carry into action, and yet retain his freedom of movement is some 200 to 300 rounds. This he could, if he was not trained to husband, expend in an infinitesimal space of time if he were armed with an automatic rifle, and yet there will be many occasions when he can only have his supply replenished at night.

Notwithstanding these disadvantages, it can, however, be safely predicted that automatic rifles will come, and that they will exercise a considerable effect. A few men armed with them, skillfully posted, may deceive the enemy as to the numbers opposed to him. For rearguards, for covering approaches, for feints, for flank defense, and for the delivery of rapid bursts of fire they will be invaluable. But the men who use them must be picked for their shooting qualities, agility and good nerves. Some nation will give the lead, and others will, perforce, follow suit.

—*The Army and Navy Gazette*, February 18, 1911.

◆ ◆ ◆

SHOULD THE PANAMA CANAL BE FORTIFIED?

Major Louis Livingston Seaman, Surgeon U. S. Volunteers during the Spanish-American War, concludes a very interesting article on the subjec

"Should the Panama Canal be Fortified," (*The Editorial Review* for March), with the following apt statement of the case:

"When Great Britain dismantles Gibraltar and Aden, the real termini of the Suez Canal,—and Germany neutralizes the Kiel Canal and the German Navy, it will then be time for the United States to abandon the fortification of the Panama Zone.

"I hope for the day

> 'When the war drums beat no longer, and the battle flags
> are furled
> In the parliament of man—the federation of the world,'

but I forsee the possibility of war, and dread it.

"As *one* of the measures to prevent it, I certainly hope the Panama Canal will be fortified; that it will be used as an incentive to encourage American ship-building, and that it will remain forever under the protection of the American flag."

✦ ✦ ✦

CANALS IN THE SERVICE OF COAST DEFENSE

Retranslated from the *Revue International*

By Captain REX VAN DEN CORPUT, Coast Artillery Corps

INTRODUCTION

An article in the *Streffleurs Militarische Zeitschrift* of July, 1909, gave an account of the principal canals now in existence, and of those under construction or being reconstructed. The article dealt with the subject from a purely commercial standpoint and did not enter into the value of canals as being of military importance.

In view of developments since the publication of this article it is believed proper to consider artificial canals from a military view-point.

All countries bordering on the seas, especially those that may be forced to contest with strong adversaries, must consider the possibility of offering other resistance to an active enemy than the conventional methods of defense now in use.

It is particularly desirable to be able to move war vessels from one section of the coast line to another without interference from the enemy's fleet, and to be able to secretly concentrate vessels at a threatened point. By aid of such an augmented fleet it becomes possible to surprise the enemy and thus render impossible a total blockade of the coast.

To accomplish this result, (that is, be able to concentrate or distribute the fleet) use is made of navigable canals which—

a. Connect the sea, or arms of the sea, by short routes and avoid the necessity of long coasting voyages around peninsulas, or shoals, far out at sea.

b. Run parallel to the coast line and afford interior navigation instead of having to send the fleet to sea in going from one point to another.

Naturally, those canals mentioned in Class (a) must have their outlets protected by Forts, while the other Class, by far the most numerous but having less protection, must have their various openings protected by mines in time of war in order to restrict entrance to only national vessels.

The safety of the home fleet, in moving from sea to sea, or along the coast, will depend altogether on such protections for freedom of movement, if the enemy is near in force.

In the latter event, the war vessels assembled in ports which communicate by means of canals may, in case they are not protected from the bombardment of the enemy or his attacks by submarines, find unassailable positions in the interior bays and basins of the canals. Even in the event of a port being captured they would have an assured line of retreat, for the enemy would never dare penetrate waters which could be rapidly and securely defended by batteries and mines.

The force of the mightiest *Dreadnought* becomes ineffective while navigating such interior water-ways, and submarines could as a rule only be employed in such waters by the defender.

Unfortunately, the construction of maritime canals is not feasible in many localities where they are needed for commercial use and especially for defense. Many times, the constructive and financial difficulties appear so great that the project is not considered.

In addition to having become accustomed to a longer route by long usage, sometimes other obstacles intervene, such as hilly or stony country, intercepting water-courses, and the variation of tides which necessitate the construction of locks and require a supply of water for their operation.

The canals are naturally most easily constructed through low, flat country where natural water-ways such as deep streams, lagoons, and lakes may be utilized. In such localities, where all or part of these aids are available, and where an apparent profit may be expected in time of peace or war, the canal should be constructed.

A glance at the map will support this statement, without considering the success of our northern neighbor. (Sweden.)

Canals may be considered of two classes:

Transversal, or those mentioned in (a).
Longitudinal, or those mentioned in (b).

a. TRANSVERSAL CANALS

Among these may be named:

The system of Swedish canals.
The Kaiser Wilhelm, (connecting the North and Baltic seas).
The Languedoc canal in France.
The Suez canal.
The Corinth canal, in Greece.
The canal between the Firth of Forth and the Clyde, Scotland, and the Panama canal.

The Swedish canals, at the present time, are being deepened over 100 per cent. Eventually, not only light draft steamers, but heavily laden merchant vessels and armored war-vessels may pass through them. This will be of great advantage in a commercial way, as it is well known that large vessels cost relatively less than small ones.

From a military point of view, little advantage is expected from the deepened canals as this peace-loving country holds itself carefully free from all political complications.

The Kaiser Wilhelm Canal is being both widened and deepened, so that the heaviest draft *Dreadnought,*—unthought of when the canal was under construction—may pass through it without difficulty.

The South, or Languedoc, canal, (or the canal of the two seas, as it was once proudly called) which commences at Garonne, a short distance below Toulouse, and extends to Cette, has been long neglected notwithstanding its apparent importance. It has become more and more dilapidated since it has been found impossible to deepen its bed owing to its passing over other waters by means of bridges and viaducts.

Notwithstanding this, from both commercial and military standpoints it appears necessary to restore this canal to service by carrying out long proposed radical changes.

Whoever examines a map of south-east Europe and reads a few pages of French history cannot fail to appreciate this canal's importance. Had this canal, navigable for deep draft vessels, existed during the reign of Napoleon the First, the fleets of France, of Italy and of Spain, could have traversed this route instead of the fatal course around Spain, and the war with England, and with that, the fate of Europe might have taken a different course.

The Canal of Corinth is of vast importance to its own coastwise trade, and to its navy, but has never succeeded in attracting foreign shipping in spite of the efforts of its promoters.

The proposed Scottish canal, which will begin to the rear of the large fortified port of Kossyth, and connect the two largest cities, Glasgow and Edinburgh, will not possess the great military value that has been claimed for it.

It is not probable that England would send an attacking fleet from that point. Neither would an enemy attack a point at the extreme north of England until it had swept the south.

Much more important, from a purely military viewpoint, would be a canal connecting the mouth of the Thames and Portsmouth, the two main harbors of the British navy. It will be seen that in case of war with France, for instance, that that country could temporarily block the Dover-Calais channel by means of its vessels and submarines and, under certain conditions, could effectually separate the fleets that would probably be in the two large harbors of the Thames and Portsmouth. The proposed canal, still only a vague project, would eliminate this danger and would materially add to the defenses of England.

The project is not impossible. Much more complicated and colossal schemes have been planned. For instance, connecting the Gulf of Genoa with the Adriatic across Italy from Spezia to the Lagoon of Commachio. And, again, in Russia, a canal connecting the Baltic and Black seas. In both of these cases, the communications will eventually be constructed, but will be available for only light draft vessles owing to the great natural obstacles which are at present insurmountable. The same difficulties attend the practical use of a canal between the Danube and the Adriatic in our own country.

The Suez and Panama canals will not be considered at length as those two great international creations, while profiting the entire world in a commercial sense, are of military value to only the two great powers of England and the United States.

b. LONGITUDINAL CANALS

There is at the present time only one complete canal of this type. It is the Imperial Chinese canal which connects the mouths of the Yantse, Hoangho, and other rivers, and runs almost parallel to the Pacific. It is of considerable commercial value, and in time, when China possesses a navy worthy of the name, will be an important military factor. The fear of the Chinese for the open sea was the original cause of its being built.

Europe, from entirely different motives from those which caused the Chinese to build their canal, are following the instructive example given by the Orientals.

In this Germany leads. Having, as a rule, low, level coast lines, the necessity of establishing communications by water between the principal cities has recently been recognized by Germany, and has been encouraged by a comparatively easy work which has proved successful notwithstanding the fact that financial doubts existed at first. The canal known as the Kiel canal, first intended to connect Kiel and Wilhelmshaven, now extends to the lower Elbe. On the opposite side of that river, the Elbe-Weser canal terminates, but it must yet be deepened in order to form a continuation of the Kiel canal. When completed this canal will connect the two principal fortified ports of Germany.

(Other canals are proposed in Germany, Russia and France, but are omitted as not being under actual construction.)

In the United States of North America unusual activity is being shown in the construction of longitudinal canals. In fact, in view of the favorable character of coast line, and configuration of the ground, the conditions are most favorable and sustain the statement that it is possible to have all things in America,—including money.

The Deutsche Rundschau of last year, as well as other authorities, states that the United States is contemplating the construction of a series of canals which will give an inland water-way the full length of the Atlantic coast. These canals will supplement the present ones and will give both small and large vessels a course free from storms, ice-floes, or the attacks of enemies. Foreign navigation companies will not be permitted to use these canals and entrance by the enemy can be securely guarded against. In pursuance of this idea, the Cape Cod canal was commenced about ten months ago. (Jan., 1910.)

While the shortest of the chain, it will be one of the most important and will have a depth of from 24.5 feet to 29 feet. It will connect Boston with the interior chain of communication and work to the northeast of that port will be undertaken later. Further south the system of canals has been nearly completed to Norfolk. The work has not been expensive owing to the utilization of the Chesapeake Bay which is really a vast natural, longitudinal canal. This magnificent bay does not run normal to the coast but turns at right angles, to the north just above the entrance and parallals the coast for one hundred and fifty miles up to about the 40th degree of north latitude.

At the well fortified entrance of the Chesapeake a second basin, extending southward, commences. This second basin is almost as long as the first and in portions has the necessary width and depth. Much work is necessary, however, in dredging and sanitary improvements. It extends to the south of Cape Hatteras and is separated from the Atlantic by dunes protected by many reefs. From that point, about 34 degrees north latitude, the bays and lagoons cease and the canal must be cut. This will require a considerable outlay of time, money and labor, but no serious difficulties will be met with.

As first contemplated the canal was to connect Boston and Charleston, terminating at the latter fortified port.

About six months ago, however, (May, 1910) the states to the south of Charleston took up the matter and began to urge that the canal be continued to the extreme southern point of Florida.

The entire project will be completed, without doubt, but difficulties may arise at the base of the Florida peninsula which may cause doubt as to the choice of carrying the canal on the east or west side of the peninsula. In either case the canal must go to the extreme southern point of Florida, terminating at Key West. That harborage is well known as the base of operations for fillibusters who depart from there for Cuba whenever one of the numerous revolutions of that country gives them any hope of profit.

Much is expected of this canal, possibly too much. At the same time it will afford employment to many people for a number of years. On its banks new towns and villages will arise, and fortifications will be built at its entrances. A heavy traffic will be maintained over its waters, and small vessels which have long feared the evil weathers of Cape Hatteras will be relieved of that danger. The swamps and fevers will disappear, reefs and bars will be removed and the channels will be straightened.

A blockade of this coast, over 1500 miles in length, will be impossible, for it would require an enormous fleet to blockade the numerous outlets of the canal, with the inevitable result of having each blockading squadron widely separated from the others. Under such conditions the defender has only to issue in force from any selected outlet, fall on the separated squadrons and destroy them.

In conclusion, another advantage may be mentioned. The canal will be self supporting, while its value from a commercial standpoint cannot be fully appreciated.

This will result from the fact that its use will be reserved for domestic shipping only, and hence American vessels will secure much of the freight that is now being transported in foreign vessels.

—*Streffleur's Militarische Zeitschrift*, No. 4, 1910.

◆ ◆ ◆

THE BOSPORUS DEFENSES

The batteries composing the sea defenses of Constantinople on the north are on the upper Bosporus, so situated as to command the entrance from the Black Sea. The sites of the forts are well within the Bosporus and are protected from a fleet standing off in the Black Sea. On the other hand, the field of fire of the batteries is very limited, being confined practically to ships that have actually entered the Bosporus. The batteries are old and the sites are not well chosen for the most advantageous use of modern guns. This is especially true of the howitzer batteries (marked No. 2 and No. 7 in the map), which are about 10,000 yards from the entrance and situated on hills near the channel, the conditions for zone firing being most disadvantageous, especially against a rapidly moving ship. There are some ideal sites nearer the entrance for mortar batteries, from which the channel for a considerable distance could be covered with one zone. All the batteries have a head-on fire except when a ship is passing them, then they must fire into each other.

A practice was held at these batteries in September. The target was anchored at the entrance to the Bosporus. Practice with a moving target was not held. In fact, both guns and men are not capable of it. The field of fire against a moving target would be small, but it would be possible to have a very interesting practice against a target pulled between the two outer points, Rumeli Feller and Yum Burnu, 5000 yards distant from each other.

The guns are all of the Krupp make except two 6-inch Armstrongs. They are mounted on the Krupp slide-carriage, and hence are somewhat out of date. In fact, the only modern guns are the Armstrongs.

Nearly all the gun batteries are situated near the water level and close to the shore. The howitzer batteries are on hills, No. 2 on a 130 meter hill.

The names of the places, near which the batteries are situated, correspond to the numbers in the map. These names and the caliber and number of guns are given below.

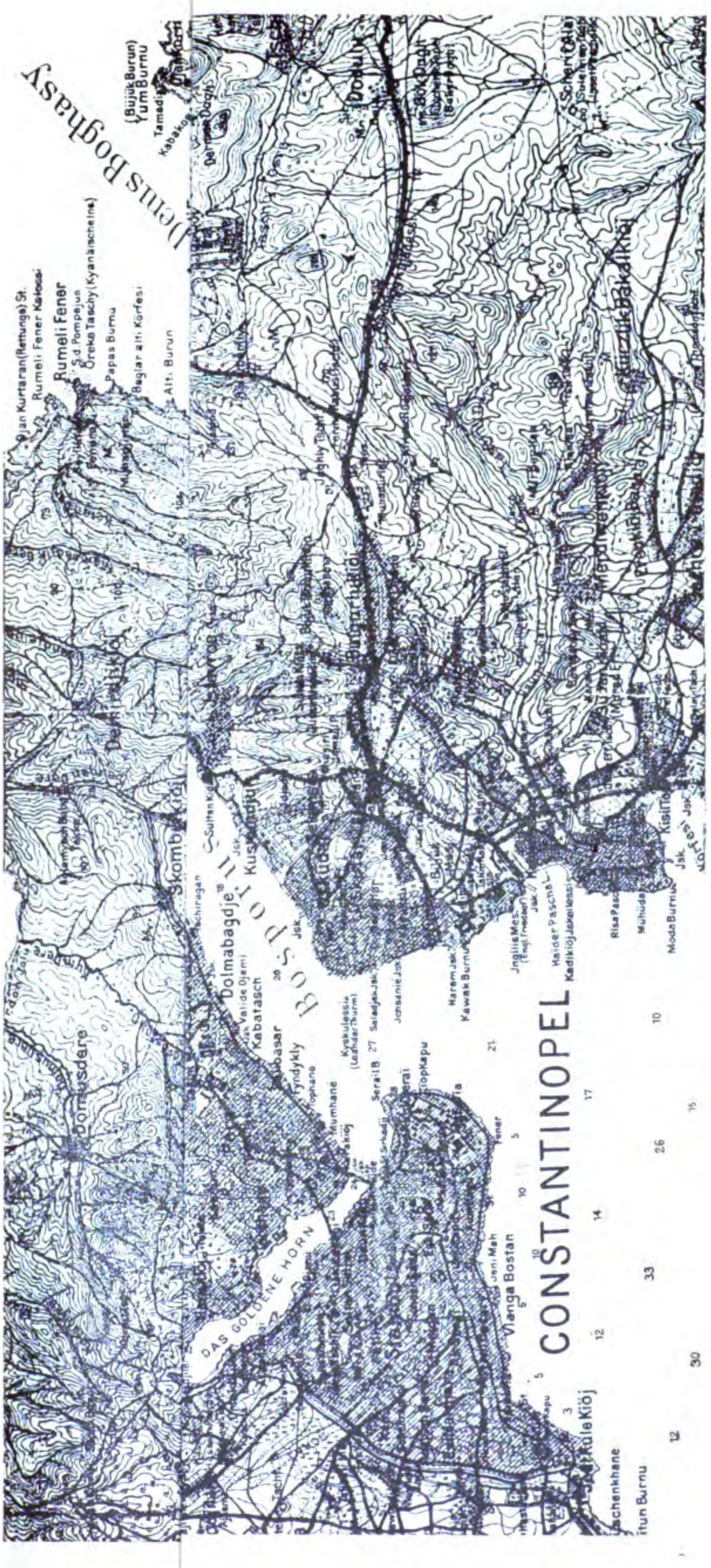
No. on Map.	Name of Place.	Caliber.	Make.	Number of Pieces.	Remarks.
1	Kiretsch Burnu	21 cm.	Krupp	3	Old guns
2	130 m. hill	21 cm.	"	4	Howitzers
3	Telli	6-inch	Armstrong	2	Guns
4	Rumeli Kawak	35.5 cm.	Krupp	2	"
5	Siratasch	24 cm.	"	4	"
6	Bujuk Liman	24 cm.	"	4	"
7	Sudlidje	21 cm.	"	6	Howitzers
8	Madjar Kelessi	15 cm.	"	10	Guns
		21 cm.	"	5	"
		28 cm.	"	2	"
9	Anadoli Kawak	15 cm.	"	4	"
		21 cm.	"	2	"
		24 cm.	"	5	"
10	Genueser Sch.*	24 cm.	"	4	"
11	Ketschili	24 cm.	"	4	"
12	Fil Burnu	15 cm.	"	3	"
13	Toiras†	——	——	——	——

*There is a searchlight at this place.
†Obsolete. No guns.

◆ ◆ ◆

THE GERMAN COAST FORTS

In close connection with the navy on the one side and the army on the other are the coast forts. These free the navy in war for the offensive and protect its bases. They serve the army by forcing an enemy to land at unfavorable points and to fight, under the conditions of the defender, for bases necessary to a successful invasion. Those that do not see the use of coast forts, because they do not cover the whole coast and therefore do not prevent a landing,


CONSTANTINOPEL
DAS GOLDENE HORN
Bosporus
Boghasy
Rumeli Fener
Rumeli Fener Kalesi
Papas Burnu
Baglar alti Körfesi
Alti. Burun
Büjük Burun
Yum Burnu
Tamadis
Kabakos
Dolmabagdje
Kabatasch
Tschiragan
Skombul Kiöj
Kuskundjuk
Domusdere
Vlanga Bostan
Jeni Mah.
Harem Jsk.
Kawak Burnu
Jngiliis Mes.
Haider Pascha
Kadikiöj
Risa Pascha
Muhuda
Moda Burnu
Kisiltoprak
Kadikiöj Körfesi
Tophane
Serail
Topkapu
Fener
Kysykulessi
(Leander Turm)
Selimije
Burgurlu
Kurtul Kiöj
Dolmabagdje
Kulekiöj
Tschenkhane
Altun Burnu
Scheri Bek
Böjük Dagh
Kaniklik
Büjükdere
Dandjakiöj
Dolmen Dagh
Kutschuk Bakalikiöj
Fenerbagtsche
Dschaffer Gol
Kandilli
Jeni Kiöj
Dansiköj

should consider that they shut the enemy's fleet out of the desirable harbors; prevent his navy from capturing the large cities, harbors and railroad terminals necessary for anything more than a landing; compel him to make a land attack and thus furnish the mobile forces an opportunity to defend these bases,—an opportunity they would not have without the forts. Germany has no doubts about the use of coast forts and is adding to those already in existence.

The scheme of German coast defense naturally divides itself into two parts: 1. That for the Baltic, and 2, that for the North Sea. Since the destruction of the Russian fleet and the talk of war with England, the North Sea defenses have become the more important. Consequently, forts to cover the entrances of all the navigable rivers,—the Ems, Weser, Elbe; and to protect the great fleet base at Wilhelmshaven are found. To prevent the enemy securing a base on the Friesian Islands, which line this coast, forts have been erected on some of these,—Borkum, Wangeroog, Heligoland. Both ends of the Kaiser Wilhelm Canal are protected. This is to the German fleet what the Panama Canal will be to the American fleet. There is no hesitation about fortifying it. Kiel, the principal naval base, is very extensively fortified. For the purpose of making the approach by sea impregnable, the Germans, if not actually bringing pressure to bear on Holland to fortify her coast, as is suspected, look at least with great favor on this plan, which would be to their advantage and to the disadvantage of England. With Holland fortified and Belgium neutral, Germany is well protected against an invasion from the sea.

GERMAN LAND FORTS AND RAILROADS

Permanent land forts are found in rear of the principal coast strongholds and along the borders. The French border is especially well fortified. These forts have somewhat the same relation to the army as the coast forts have to the navy in that they afford points of support and give to a defending army greater mobility.

In close connection with Germany's scheme of defense and also plans for offense in Europe is the magnificent network of railroads. These are built partly with the idea of quick transportation of troops. All the borders are well covered with them and connected to the interior by main lines. Switching facilities are a special feature of German roads. In planning new roads, the officials consult the General Staff. What these roads can do has been shown in the transporting of troops out of the maneuver districts. In Germany, with less than 290,000 square miles of surface, there were, in 1909, 37,000 miles of railroads.

THE MERCHANT MARINE

For over-sea warfare the merchant marine comes into consideration. In 1909, Germany had 1,953 steamers with 2,300,000 tons and 72,000 men in the service. For an expedition, the large ships are most advantageous, since with a few ships a large force can be transported. Germany is especially well supplied in these. The large ships of the North German Lloyd and the Hamburg-American Line are available to transport troops. The latter line is now building a ship of 50,000 tons, twice the tonnage of the present largest ships. Since the navy is superior to that of the United States, this immense merchant marine becomes a matter of concern and should lead to thoughts of an adequate army to support the coast works. While a superior navy on the part of the United States would tend to lessen the danger of invasion, it would not be a sure guarantee. Napoleon went to Egypt with the English navy in the Mediterranean, and the Japanese did not wait for a destruction of the Russian fleet before transporting troops to Manchuria. These observations are made on the theory that the United States should have such military strength that its position is impregnable against the strongest nation,—whether it is friendly or not.

To complete the sketch of Germany's military strength it is only necessary to mention the immense arms and ammunition works which thrive in peace by supplying not only the German army, but also those of nearly all the lesser countries. Among these works are the Krupps, Ehrhardts, Deutsche Waffen and Munitionsbabrik, Mauser, Westfaelisch-Anhaltische Sprengstoff, A. G., Koln-Rott-weil Pulverfabrik, Poltefbbrik, etc., besides the government factories.—*National Defense*, March, 1911.

✦ ✦ ✦

THE PURITAN EXPERIMENT

The following statement has been made by the United States Naval Bureau of Ordnance concerning the high explosive test against the *Puritan* on November 25:

1. The test of high explosive charges against the side and turret armor of the *Puritan* was made in accordance with a provision that such an attack should be made against an actual ship, and specified both the character of the explosive to be used and the weight of the charges.

2. The explosive was that known as "explosive gelatine," well known as the most powerful of all the nitro-glycerine compounds used for military or blasting purposes, and one of the most sensitive of such compounds. The charge was in each case 200 pounds, which is believed to be the largest charge of this explosive ever detonated.

3. The *Puritan* was selected for the test because, although much weaker in resisting power than a modern battleship, she was perfectly available and was considered to present more favorable all-round conditions for the test than any other ship which could wisely be used at this time, it being recognized that a test so extreme as this one could not fail to result in damages serious enough to call for repairs which might cover considerable time. The turret armor of the *Puritan* has a thickness of 8 inches, as against 12 and 14 inches in battleships of latest design, and the side armor at the point attacked was 10 inches thick, tapering to five inches at the lower edge of the belt. The *Puritan's* belt armor extends only about 3 feet below the normal water-line, and only 2½ feet below the existing water-line at the time of the test.

4. The explosion against the turret armor set back the plate against which the charge was placed, dishing it cosiderably and opening a number of deep cracks, some of which probably extend through the plate. The seams between this and adjoining plates were opened as were also those between the next two plates. It is not known whether the turret can be framed, as the test of this point could not be made until certain plates which had been inserted between the turret and the barbette shall have been removed after

the return of the ship to the navy yard, but no pipes or joints in the mechanism were disturbed, and there was no evidence inside the turret of any disturbance whatever. Two chickens and a cat, which had been placed in the turret at points where the crew would be stationed for working the guns were entirely uninjured.

5. With regard to this test, it may be said that, as far as is apparent at the present time, the turret was not in any sense vitally damaged.

6. The second charge, against the armor belt, buckled the plate against which the attack was directed, swinging the ends of the plate outward and opening up the seams at the ends. The lower edge of the plate was also buckled outward, opening up a longitudinal seam below water, and starting a bad leak through which the water-tight compartment affected was rapidly flooded. It is impossible to say what damage was done below the armor belt, but there is no indication that this was serious. The narrowness of the armor plate undoubtedly contributed very largely to the result produced. The wider plates of a battleship's belt would have resisted buckling more effectually, and the longitudinal bulkhead, which exists in all modern ships, would have confined the flooding within narrow limits. As a result of the leaks, which in the *Puritan* gave free access of water to the whole of a large compartment running entirely across the ship, the stern of the ship settled about 12 inches, and at low water seemed to touch bottom, the depth of the water being only one foot in excess of the draft of the ship. With a rising tide the ship floated, showing that the reserve buoyancy of the after compartments was ample for taking care of the leak.

—*United States Naval Institute Proceedings*, March, 1911.

◆ ◆ ◆

THE RESUSCITATION OF SECONDARY ARMAMENTS

The history of the growth and the subsequent temporary suspension of secondary armaments—by which term we imply those weapons which, while not of the heaviest caliber, are undoubtedly fitted on board all except certain recent classes of British ships as additional fighting guns rather than a purely anti-torpedo boat armament—is one that is, as far as British naval practice is concerned, most intimately connected with the influence of target practice and theory during the last decade. In the last five years no secondary weapons have been fitted at all on board British ships of the heavies classes, though abroad their use has been retained by navies which have undoubtedly been compelled, in one or two cases largely against their will, to adopt the primary armament affected by British constructors. Generally speaking, the history of the so-called rapid-firing secondary armament dates from about 1886, when the Armstrong 30-pounder quick-firing gun first appeared, which weapon soon developed into the 4.7-inch 45-pounder. Of course, the Admiral class and the Victorias had batteries of smaller guns in addition to their heavier primary weapons, but the legitimate quick-firer with the single action breech block is of much later date. The standard armament of two pairs of heavy guns disposed in turrets at the ends of a central citadel, supported by a central broadside battery or casemates of 6-inch guns on the main and upper deck, remained as such in the Royal Navy from the Royal Sovereign class of 1889, in the Majestics, Glorys, Implacables, Duncans, all through till the time of the King Edwards in 1903, while a similar design, as far as the secondary armament went, was applied to the contemporaneous classes of cruiser. During the fifteen years that elapsed the many improvements in detailed mechanical design of sights, mountings, and breech-blocks, and also in systems of training men, enabled considerably higher rates of fire to be obtained, though during the same period the maximum absolute size of ship or height of gun platform underwent relatively little change. Three wars—those between Japan and China, the United States and Spain, and Japan and Russia—went far to attract attention to the potentialities of the gun in a way that academic discussions in gunnery schools could never emphasise. The paramount importance of inflicting the maximum amount of damage on a target in the minimum of time, although doubtless appreciated ever since the old three-deckers were built, was never adequately understood until the Japanese war of 1895 demonstrated the possibilities of the 6-inch quick-firing gun, and till the war of 1904-5 had proved what the previous one might also have done had the weapon been present—that is, the destructive power of the 12-inch gun. Soon after the first war the systematic training of gun crews to hit the target —not merely to fire rapidly—was begun, and the initial efforts were undoubtedly due to Sir Percy Scott. As this training developed over a period of years, it rapidly became evident that only those weapons that were, so to speak, comfortably arranged, were really of value. Of course, for many years previously the evils of interference between large and small guns had been appreciated, but it was more from the shooting end; and the systematic organisation of men and instruments for the purpose of fire control, with the sole object of hitting the target, is of comparatively recent date. The introduction of scientific fire control, coupled with the mechanical improvements that enabled the higher rates of fire to be obtained, resulted in many discoveries. In the first place, the "spotting" of hits at long ranges when all guns, that is to say, both primary and secondary weapons, were in action, was found to be extremely difficult. In previous times, when the quarterly stationary target was fired at, as long as it was hit nothing was said; there was little difficulty in hitting it when guns were fired singly. But on the introduction of battle practices, with all guns turned loose together, it became harder on account of the difficulty of accurately locating the fall of the projectile in the water. Up to about 5000 yards it is possible to follow the flight of a shot and locate its splash, whereby correction can be made for inaccuracies in range and training; but above this range—and the battles of the Russo-Japanese showed the necessity of not closing too much—it becomes impossible to identify the splashes unless there is a marked difference in the caliber of the shot, such as exists, for instance, between the 12-inch and 6-inch projectiles. Rangefinders alone are not sufficient for fire control, and owing to the variation in danger space at long range between two such calibers, separate range-finders are necessary in any case, even though sight correction be finally adjusted by the time-honored method of watching the splash. Now, in controlling a mixed armament, the ship steaming ahead with the guns trained on the beam, the forward turret is situated very favorably, but the guns further aft—and this applies especially to a 6-inch battery, which may be firing a gun every other second—will be working in a heated powder haze which makes aiming very difficult, and sighting through such an atmosphere is almost useless. If time is allowed to elapse in order to get a clear view, then the loss due to this interference is considerable. The loss due to interference from "blast" is even worse. Further experiences of battle practices proved conclusively that this system of independent firing did not result in the maximum number of hits; the after 12-inch turret especially was affected by this gas discharge. It then gradually became the custom to fire simultaneous salvos which, while reducing the number of rounds fired per minute, unexpectedly increased to a marked extent the number of hits on the target in a given time. Simultaneously with the increasing attention paid to target hitting, among other things, came a vast improvement in torpedoes. This in itself would be a contributory reason for going to longer ranges, even if the improved accuracy of 6-inch fire did not dictate it. But as the range increased, so did the difference in danger space between the 12-inch and 6-inch weapon, and as hitting depends on estimating the limits of the danger space as accurately as possible, a marked preference for the larger caliber gun, which gave the greater margin, was forced on naval artillerists. The system of observing the splash from a masthead fire-control platform, such as is adopted in the British and United States navies, had clearly shown what difficulty lay in detecting the difference between the 12-inch and the larger secondary calibers—8-inch, 9-inch, or 10-inch weapons. Reasons, also of a tactical nature, in view of the prevailing tendency to adopt longer ranges, influenced the sudden adoption of the numerous 12-inch turrets; for one thing, the maximum concentration of effective fire was made more possible; but, in any case, the introduction of such an armament in the Royal Navy, and the suppression of all other, except anti-torpedo boat weapons, was due to a long and carefully reasoned process of evolution based on experimental and practical data of the most elaborate kind. This state of affairs has obtained for nearly five years, and there is now a strong tendency in some quarters to demand a resuscitation of the 6-inch weapon. It is interesting, as well as desirable, to consider the arguments on which this idea is based; certainly, it is the process of evolution being carried a stage further.

When the Dreadnought first appeared it would admittedly have been suicidal for any other individual ship to attack her, and there was little danger of her exposed 12-pounder armament being so damaged as to render her anti-torpedo defense at all deficient. Foreign destroyers, moreover, were then still in the 500-ton stage. In the later vessels, of the Bellerophon and Neptune classes, these guns were replaced by equally exposed 4-inch guns; the size and speed of foreign destroyers was increasing, but still the Dreadnought type had little to fear from any foreign battleship. The size of ship, meanwhile, was also steadily increasing; consequently the height of the decks above the water was much more than in the King Edwards, and no interference with main deck 6-inch guns, due to rough weather, would have occurred in the newer ships, such as was so bitterly criticised in the older vessels. A main deck armament, however, of heavy quick-firers, is difficult to arrange satisfactorily when side turrets are employed. The supply of ammunition and the magazines are not convenient, but these difficulties disappear very largely in vessels with center line turrets like those found in the newer battleships. Now, just as the danger space of the 12-inch gun is greater than that of the 6-inch, so is that of the 6-inch greater than that of a 4-inch weapon. With the advent of foreign Dreadnoughts—there are now five in commission in Germany—the possibility of manning during a battleship action the exposed 4-inch guns, which was still feasible in an action with a pre-Dreadnought type vessel, is not to be considered. These guns should be tected, and if they are to be adequately protected they must be placed lower on account of considerations of stability. The only place to put them then is on the main deck. This involves a reduced command, and owing to this, as well as to the fact that ranges are still tending to increase, a higher powered gun is necessary. What is this to be—4-inch high velocity, or 4.7-inch? The latter is a waning type, the 4-inch being probably just as good for service purposes. Or is it to be a 6-inch weapon, which, in these days of 13.5-inch guns, must not now be reckoned at all as a secondary armament, but rather as a larger and longer range anti-torpedo gun? There is no need to discard the 4-inch superstructure weapons; for night work they will be better than the 6-inch, which makes too great a flash; but with the larger and faster foreign destroyers, and the longer ranges inevitable with the bigger primary weapon, a heavier anti-torpedo gun is required. Whatever its original status may have been, it must now be regarded solely in this light, and not as a gun for fleet action work. Although an armored 6-inch battery is found in the German Dreadnoughts, it is obvious that it was placed there for battle purposes, and not as an anti-torpedo gun. The same applies to the 7-inch guns in the United States ships. The reasons which led the British Admiralty to initiate the all-big-gun one-caliber type of ship will hold good for a long time, and no resuscitation of mixed armaments after the King Edward or Achilles style will be adopted. That an early return to armored main deck guns is pending may be taken for certain; the risk of damage to the unprotected superstructure guns is now too great with foreign vessels of approximately similar gun power to our own. There is some probability of misinterpretation of Admiralty policy arising with regard to the distinction between secondary and anti-torpedo armaments should it be found advisable to re-introduce the 6-inch gun, but the principles of fire control will continue to hold, and misapprehension of the gun's true functions is not likely to arise in the minds of the users, which, after all, is the really important matter.

—*The Engineer*, November 11, 1911.

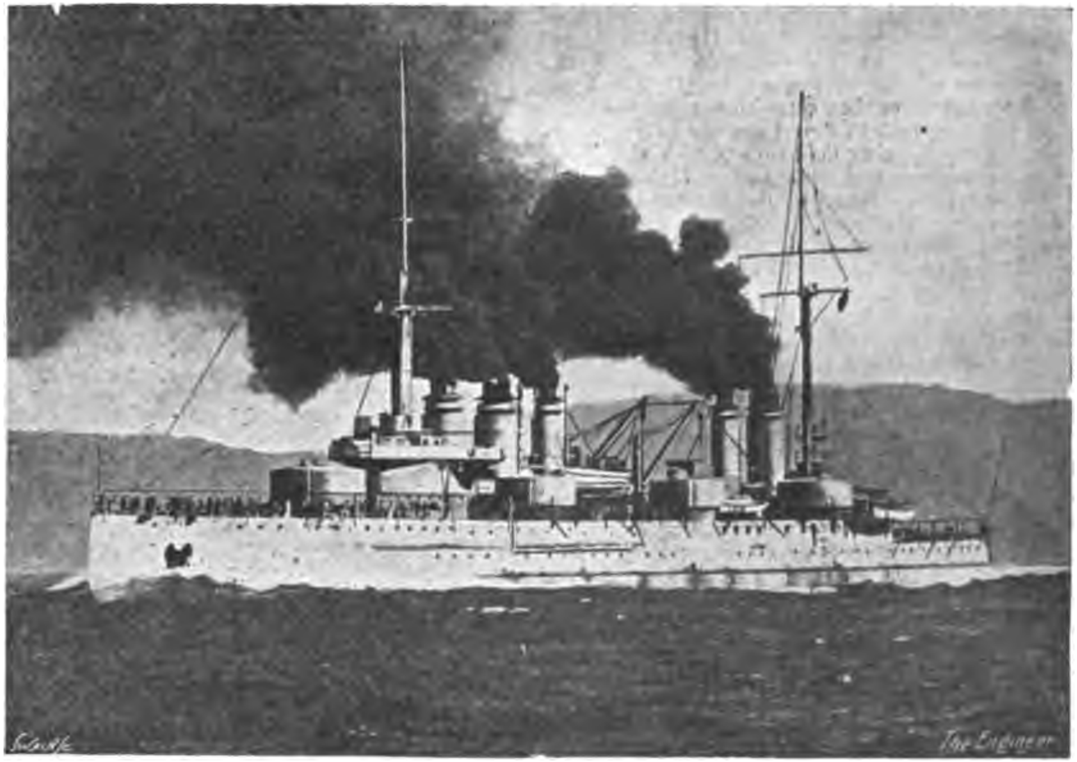
✦ ✦ ✦

FRENCH BATTLESHIPS

(Extract)

The class of French battleships with which this article deals was designed in 1904 at a time when the wisdom of the all-big-gun policy was in more doubt even than at present. In France at the time division of opinion was very keen, but ultimately a mixed armament was decided upon, and the vessels now carry four 12-inch and twelve 9.5-inch guns, all in pairs, besides sixteen 3-inch and other minor pieces. This is not the place to revive the discussion, but we may recall that at the time the *Voltaire* and her sisters were designed the accuracy of fire from big guns was not so great as it is now, and it was felt by many authorities that it was wiser to get in many lesser hits than an occasional big one. The argument took the line that the smaller pieces should be used until the enemy was disorganised and his nerve destroyed, when there would be no difficulty in completing his destructon with the heaviest guns.

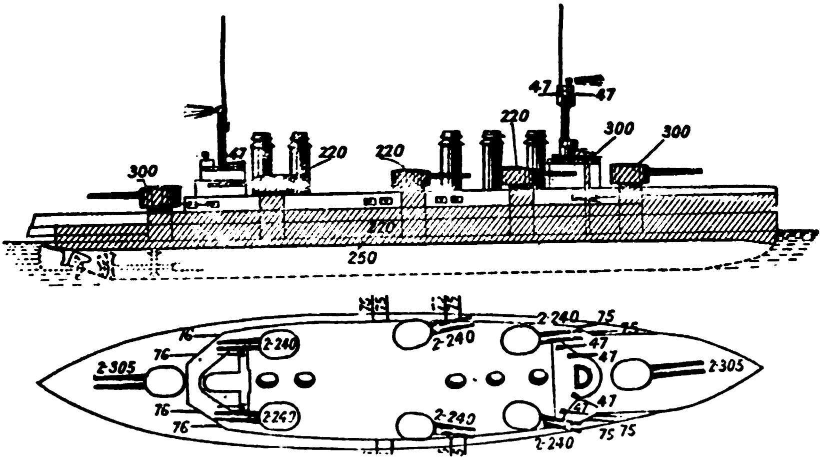
The value of 12-pounders is, of course, as much open to question on these French battleships as it was on our own early Dreadnoughts, which synchro-



THE FRENCH BATTLESHIP VOLTAIRE

nise in time with them. Nothing less than 4-inch is now deemed likely to be an effective arm against modern ocean-going destroyers.

The *Voltaire* and her sisters have suffered the usual vicissitudes of French warships. Designed, as we have said, in 1904, they have undergone in the years that have elapsed many changes, and though they are now approaching completion, it is not impossible that further alterations may be made. They were originally to have had reciprocating engines, but with the rapid development of the turbine that means of propulsion was dropped and the latter adopted; they were to have had rams, but fashion changed before they were laid down—1907-8—and they were given liner stems; it was intended that they should have double bottoms as a protection against torpedoes, and the *Voltaire*, at least, is so built, but experiments on models having proved the theory of the double bottom imperfect, the *Condorcet* has not that form of protection. This relinquishment of a design which other nations are now adopting was brought about largely by the argument that it was better to expend the available weight in heavier side armor. The greatest danger a ship has to fear is capsizing; if she can but keep a level keel there is still some hope for her, and it was therefore felt that it was wiser to protect the sides than the bottom.



THE VOLTAIRE CLASS

Amongst improvements which these vessels show over earlier designs one of the most notable is the conning tower. It is now a very elaborate structure, about twice the size of that of the *Patrie*. Its walls are of armor 12-inches thick, and it is oval in plan. The shield at the entrance, which is large enough to admit only one man, has been omitted, but this entrance has been placed aft instead of forward. Within, the conning tower is divided into two parts. One gives an excellent view on both sides and forwards. In it there are a compass, electrical steering gear and rudder indicator, and a service of loud speaking telephones to all parts of the vessel. In the other chamber there are two lookout places, giving views on the sides and over the stem. On the top there are two smaller rooms, to which access is gained from below; each will accommodate two men. They have no roofs, but are of such a height that only the inmates' heads are exposed. From here an excellent view all round, only obscured somewhat to the rear, is obtainable. There is no conning tower at the stern, an omission which is criticised in some quarters.

These six vessels—*Voltaire*, *Vergniaud*, *Mirabeau*, *Danton*, *Diderot*, and *Condorcet*—displace about 18,350 tons each; they are 475 feet 9 inches long between perpendiculars, 84 feet 8 inches wide, and draw 27 feet 8 inches at the stern. They have no metallic keels, but one of teak extending the full length, and at 27 feet 3 inches from it on each side docking keels about 104 feet long. These keels are covered with zinc. Further up on each side is a bilge keel extending nearly two-thirds of the length. The stem is of forged steel and the stern frame of cast steel. On each side there are nine keelsons, and there are 145 frames at about 32 feet from each other. The hull is divided into nineteen main water-tight compartments. Sections* of the *Voltaire*, which differs from the others in possessing the anti-torpedo chambers, are given below. The plates of the lower protective deck are $1\frac{13}{16}$ inches on the flat and from $2\frac{3}{8}$ to $3\frac{9}{16}$ inches thick on the slope. The splinter deck, which extends from end to end at the height of the upper edge of the side armor, is $1\frac{3}{8}$ inches thick. The belt is complete. Forwards it stands 17 feet 5 inches above the load water line, and amidships and astern 7 feet 11 inches. Forwards it extends 5 feet 11 inches below water, amidships 5 feet 3 inches, and astern 2 feet 8 inches. This armor, including the ship's plating, has the following thicknesses:—

	Upper edge.	Lower edge
First strake—		
Between the 12-inch turrets	$9\frac{13}{16}$	4
Forward and aft	$7\frac{1}{16}$	$3\frac{1}{8}$
At the ends	$3\frac{1}{16}$	$3\frac{1}{16}$
Second strake—		
Across and between the 12-inch turrets	$8\frac{11}{16}$	$9\frac{7}{8}$
Towards the stem	$7\frac{1}{16}$	$7\frac{1}{16}$
Towards the stern	$6\frac{11}{16}$	$6\frac{11}{16}$
At the ends	$6\frac{1}{2}$	$6\frac{1}{2}$
Third strake—		
From stern to forward 12-inch turret	$2\frac{9}{16}$	

The armor lies on a teak backing about 3 inches thick, the plating behind being $\frac{19}{32}$ inch. Astern an armored bulkhead connects the side armor. The space between the armored decks is divided by longitudinal and transverse walls. On the outside is a cofferdam extending from stem to stern, then a passage, then four storerooms, and finally a center passage—see cross sections* below. All important parts rising through these two decks are protected by special cofferdams.

The anti-torpedo chamber of the *Voltaire* is about 16 feet 5 inches high by 8 feet 2 inches wide amidships; it extends from the stem to stern and is made of plates about $1\frac{1}{2}$ inches thick. At the center an inner cofferdam extends from the ship's bottom to the slope of the protective neck. Forward and aft of this the coal bunkers provide similar protection. This method of protection was first introduced in the *Zarewitch*, built by the Forges et

---

* Illustration not reproduced herein.

Chantiers de la Mediterranee in 1899, and it is said that the ship's survival of the Russo-Japanese war was due to it.

The armament of the *Voltaire* is composed of four 12-inch 50-caliber guns in two axial turrets fore and aft, and twelve 9.5-inch guns in six turrets on the spar deck. There are 16, 12-pounders, 10, 3-pounders, and two 18-inch tubes, submerged. The 12-inch guns are protected by shields 12 inches thick with covers $1\frac{1}{4}$ inches thick. The barbettes are $3\frac{11}{16}$ inches between the two armored decks, $7\frac{7}{8}$ inches from there to the gun deck, and 11 inches thick where exposed. The 9.9-inch guns have shields $8\frac{11}{16}$ inches thick, with tops $1\frac{1}{4}$ inches thick. Their bases, or stems, are $1\frac{13}{16}$ inches thick between the protective decks, $2\frac{9}{16}$ inches between the upper protective deck and the gun deck. The outer tube is $1\frac{3}{8}$ inches thick between the protective decks, and the fixed portion above is $7\frac{7}{16}$ inches thick.

The plan taken from *Jane* shows the arrangement and bearing of all pieces. The boilers of these six ships are of the Niclausse and Delaunay-Belleville types, the *Diderot*, *Condorcet*, and *Vergniaud* having the former, and the *Voltaire*, *Danton*, and *Mirabeau* the latter. The boilers are divided into two groups, one forward and the other aft of the main engine-rooms.

The *Voltaire* is the first French battleship to be fitted with Parsons turbines. There are six ahead and four astern turbines situated in three water-tight and independent compartments. In the center compartment are the cruising and low-pressure forward and astern turbines driving the two center shafts. In each of the other compartments are the forward high-pressure and astern turbine. The condensers are placed aft in another water-tight compartment.

* * * * * *

—*The Engineer*, March 17, 1911.

◆ ◆ ◆

THE POWER AND PROTECTION OF BATTLESHIPS

In the design of warships three factors stand out beyond and above all others; they are gun-power, speed, and protection. Every vessel embodies a compromise of these three factors, more weight being given to one or the other as the services on which the ship is to be employed may demand. Thus, in the destroyer speed is of such paramount importance that protection is reduced almost to the vanishing point, and the offensive power is practically concentrated in a single arm, the torpedo. In the cruiser also, if we omit the smaller fry, which are reserved for police duty, speed again is of such consequence that much of the armor must be sacrificed to ensure it. Until recent years gun power was also subordinated to this quality, but the modern cruiser is given offensive power, equal to that of a battleship, and the only sacrifice she makes for speed is a lack of protection. In the ship of the line the compromise between the three factors is complete; she must be speedy, powerful, and fully protected. The ratio in which these qualities should be combined will always be a matter for disagreement and debate. For many years it was the British practice to provide less hitting power than in ships of other navies, but by degrees, under Sir Philip Watts, who brought the experience in this direction of Elswick to bear, our battleships have been armed to the teeth as fully as those of any nation.

A few weeks ago, in discussing the Navy Estimates, we made a number of rough calculations as to the relation between weight of armament and displacement in English and foreign ships built during the last two decades or so. We based these estimates on the presumption that the weights of mountings and ammunition varied as the cubes of the calibers, and we showed that in seventeen years we had increased the weight of guns per ton of displacement by 70 per cent. We also pointed out that the ratio between gun weight and displacement was of the same order in all the big navies, the greatest differences being between America and Japan, the former having a figure of 1.4 and the latter of 2.0. Professor Welch, in the paper read before the Institution of Naval Architects yesterday, has examined the same question in a rather different way, but with not very dissimilar results. He has taken the familiar method of comparing the broadside with tons of displacement, but his earliest ship, in battleships, is the *Duncan*, and in cruisers the *Indomitable*. Now the *Duncan* can throw .29 lb. of shell per ton of displacement, whilst the *Conqueror* can throw .56. By our method of estimating, the ratios were—*Duncan* 1.1, and *Orion*—sister to the *Conqueror*—1.7. The difference between the two figures is one of no little interest. Bear in mind that our figures showed the weight of gun, whilst Professor Welch's show indirectly the weight that can be brought to bear on one broadside, and it will be seen that the difference indicates that a greater proportion of the gun power of a ship can be directed on one target than used to be possible. This is seen better, perhaps, by contrasting the *Dreadnought* with, say, the *Neptune*. Both carry the same number of guns of the same caliber, but the primary broadside of the first is 6800, and of the latter 8500, owing entirely to the fact that only eight of the *Dreadnought* guns could bear on one broadside, whereas the *Neptune* can use all hers. The value of this feature is even more strongly brought out when we remember that the *Dreadnought* carries a greater weight of gun per ton of displacement than the *Neptune* does. Professor Welch's figures indicate, just as ours did, that there has been steady improvement in the hitting power of ships per ton weight, and he might have made the increase even more marked if he had taken the muzzle energy per minute instead of only the weight of projectile regardless of rounds per unit of time and velocity. But, in battleships at least, a factor of equal importance with gun power is protection, and we could wish that Professor Welch had seen his way to give us the actual ratio it also bears to the displacement in succeeding ships and in different navies. He touched upon the matter in the course of the paper, but did not deal with it in his long table of ships, no doubt because the particulars are difficult to secure. Is it too much to hope that on another occasion he may see his way to develop the subject by dealing with this aspect of warship design?

We turn from Professor Welch's vastly interesting monograph to another which is more likely to escape the attention of English readers. It is by Rear-Admiral Goodrich, of the United States Navy, and will be found in the *Journal of the United States Naval Institute* for March. Admiral Goodrich, as far as battleships go, is a heavy protectionist. His view is that too great a proportion of the displacement is being given to the guns and speed, and that more should be devoted to armor. In considering his views it is worth recalling that the gun weight of American battleships is already less than that of any other nation—though their gun fire, from Professor Welch's table, is only excelled by our own—and it is therefore possible that their protection is greater. Admiral Goodrich is in favor of a very simple ship, and he selects the *South Carolina* as typical of the approved class. This vessel carries only eight 12-inch guns, and her ratio of pounds of shell per ton of displacement is only .43, as contrasted with the .56 of our *Orion*. She is, however, well protected for her size, having a 12-inch-10-inch belt. "Tested by the old eighteenth century rule that 'a ship is built to fight her fellows,' " says Admiral Goodrich, "all modern battleships, no matter what the flag, will be found wanting. In my judgment this state of things is serious. It can only be remedied by assigning of the displacement a larger fraction than is our custom to 'protection,' and this remedy can be greatly facilitated by avoiding extreme lengths in the ship herself, and by frankly abandoning the fad of excessive speed." "A fifth turret," he continues, " introduces complications that are by no means insignificant. . . . If more battery power is required, is there any reason why three 12-inch guns each might not be placed in their—*South Carolina* and *Michigan* type—lower turrets, or in all? If this is impracticable or undesirable, make her guns heavier, but never let us be diverted from that which is sound and good because other nations are groping in the dark and producing vessels that, in comparison with our simple and powerful *Michigan*, may not unfairly be termed freaks." Needless to say, Admiral Goodrich's views place him in a minority. All nations, including his own, keep on adding to speed, gun power, and protection of their ships, and there is not a particle of likelihood that they will cease to do so. The wisdom of that course can only be resolved by a great naval war. Until competing navies are put to that test they will play a game of bluff, each one endeavoring to produce a type more powerful in tooth and claw than the others.

—*The Engineer*, April 7, 1911.

◆ ◆ ◆

NEW FEATS IN AVIATION

The progress being made in aviation this year appears to be as rapid as during 1910. Curtiss has perfected his aeroplane so that he can start and alight on land or water at will, thus leaving nothing further to be accomplished in the fundamentals of dynamic flight. Wireless messages have been transmitted from an aeroplane in flight and received by land stations 40 miles away, while early this month McCurdy's biplane, at a height of 1,500 feet above Palm Beach, Florida, was able to catch messages from Key West, and even from a steamship leaving Panama, that is, over distances as great as 1,000 miles, and this despite the fact that the wireless operator was provided merely with a makeshift headpiece of towels to bind the receivers to his ears and protect him from the noise of the unmuffled motor. Thus, if ever a transatlantic aeroplane becomes a reality, its aviator may be in touch with both New York and Paris during his trip across. As for long-distance communication by wireless, messages are now being regularly sent from Glace Bay, Nova Scotia, to the Eiffel tower at Paris, and the Hertzian waves have been transmitted and received successfully in the opposite direction.

As for performances at flying, several spectacular and astonishing flights have been made during the month. The first of these was on March 3rd, when Lieut. B. D. Foulois and Philip Parmalee flew from Laredo, Texas, to Eagle Pass—a distance of 116 miles—without a stop, at the rate of 54.85

miles an hour. They carried rations for several days and made the flight for scouting purposes like those of actual warfare. During the entire trip they were in wireless communication with various land stations. Two days later Lieutenant Bague, of the Fourth Algerian Rifles, in an attempt to fly across the Mediterranean via Corsica and Sardinia, lost his way but finally alighted safely on Gorgona, a small wooded isle between Corsica and Leghorn. He covered 138 miles straight-line distance above the sea while flying for several hours, in his Bleriot monoplane. The actual distance traversed was much greater, for the aviator lost his way and only managed to make Gorgona just before his fuel became exhausted.

The third recent great flight occurred on the 7th instant, in competition for the special Michelin prize of $20,000 for a flight with a passenger from Paris to the Puy de Dome Mountain—an air-line distance of 222 miles—within an elapsed time of six hours. M. Eugene Renaux, with M. Senoncque as a passenger on board his Farman biplane, circled the Arc de Triomphe soon after 9 a. m., and headed for Clermont-Ferrand. Five hours later he circled the spires of the cathedral at the latter village and alighted on the top of the Puy de Dome, 4,800 feet above the sea. He accomplished the flight in 5 hours and 8 minutes elapsed time, of which but 4 hours 51 minutes was actual flying time, making an average speed of 44¾ miles an hour.

—*Scientific American*, March 25, 1911.

✦ ✦ ✦

LUBRICANT CHARACTERISTICS

PART I

The object of lubrication is to overcome one of the fundamental principles of nature, friction. It has been realized for ages by scientists that if they could obtain surfaces absolutely without friction or resistance of any kind, they would have obtained a much desired goal, perpetual motion. However, they have approached this condition by means of a partial vacuum, highly polished bearings, journals of the knife blade order and perfected lubrication; in watches and delicate instruments of precision, jewel bearings are used to great advantage.

The lubricant should form an undecomposing layer between moving and stationary parts, should have the least internal friction (due to the moving about of particles of which the lubricant is made up), and should keep the surfaces away from each other. As minute irregularities exist more or less in metal surfaces, the question of lubrication, therefore, resolves itself into getting something that will hold the parts away from each other and prevent their being in contact. By many it is thought that the only thing that will meet this requirement is a fluid.

FRICTION OF LUBRICANT

Where a fluid is used, there are two kinds of friction to be dealt with: *A*—friction of the parts, *B*—friction of the fluid or internal friction. *A*, the first kind of friction, exists where the lubricant is unstable or works away from the rubbing parts, that is, allowing the metal surfaces to get into actual contact. The amount of this type of friction depends upon the kind of metals which are in contact and it is much greater than the internal friction of the lubricant.

The friction of the fluid, *B*, is caused by either one of the two conditions; that is, the fluid is made up of small minute globules approaching irregular-shaped balls, or else of minute films, which are constantly sliding over each other, and when the oil is in rapid motion, such as the intervening film between a bearing and journal, the part which is immediately in contact with the bearing is at rest, while the part between and touching the shaft is in rapid motion.

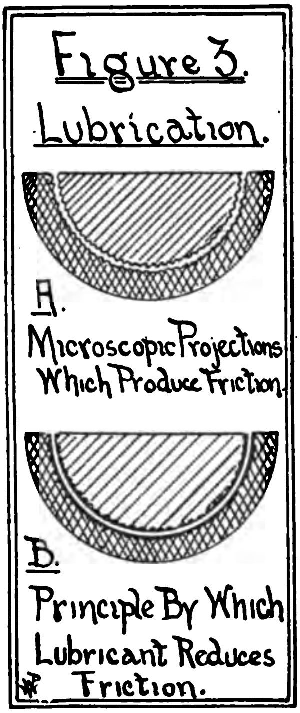


Figure 3.
Lubrication.
A.
Microscopic Projections Which Produce Friction.
B.
Principle By Which Lubricant Reduces Friction.

Reproduced through courtesy of New England Automobile Journal

VISCOSITY A FACTOR

The co-efficient of friction of the lubricant itself is generally expressed by its viscosity, which means its rate of flow. This is determined by noting the length of time which it takes a certain amount of pure water at a given temperature to pass through a small orifice, compared with the length of time required for the same amount of oil to pass through the same orifice at the same temperature. It is the consistency of the lubricant at working conditions which determines just how much this fluid friction is.

REQUIREMENTS OF A LUBRICANT

First, it must have sufficient body to prevent seizing of the parts with a minimum of co-efficient of friction.

Second, must not gum, dry or be injurious to the parts lubricated.

Third, the character of the work demands that, within certain limits, the lubricant must not vaporize or stiffen.

Fourth, must be free from acids, alkalies or other injurious agencies.

Fifth, must be carefully selected for the particular work required.

Sixth, must be a good conductor of heat.

Figure No. 3—*A* shows a cross sectional view of the bearing surfaces and how the irregularities would show under the microscope. No. 3—*B* shows how microscopic irregularities are smoothed out by the application of flake graphite and cutting edges and points rendered harmless.

As before stated, the object of a perfect lubricant is one which will perfectly separate these surfaces and at the same time has the minimum co-efficient of friction in itself.

This next leads to the different kinds of lubricants, and they may be completely grouped into three classes: Fluid, semi-fluid and solid.

—*Graphite*, December, 1910.

PART II

FLUIDS

A disadvantage of a fluid lubricant is that the same does not have sufficient body for classes of work requiring a protecting film without approaching that class of lubricants which is of necessity of a very viscous nature. Another very serious disadvantage which oil has, is that when used in a transmission gear case where there is a continual clipping of the gear teeth, and as the oil is constantly agitated, some of these metal particles are carried to the bearings and serious cutting results.

CYLINDER LUBRICATION

For a gas engine cylinder lubricant it must be one which will stand a high temperature. It has been roughly estimated that the temperature of the gas engine during some parts of the explosion stroke is over 2000 degrees, therefore it is necessary that at this temperature the lubricant be one which will not burn at all, or else leave the least carbon deposit behind. As it is impossible to get the first condition, we have to find an oil which will best meet the latter condition.

Where the lubrication entirely depends upon the splash system, the crank end of the piston is well lubricated, while the head end receives scarcely any lubricant at all, with the result that the piston rings become fouled and bound with a hard carbon deposit.

Other disadvantages of oils are that it is necessary to have a special kind of oil for the work required; and when changes of temperature are encountered, this again necessitates a change and a loss in efficiency. Again, oils will not stay where you want them.

SEMI-FLUID LUBRICANTS

Under this class are grouped greases of different melting points, from the soft greases up to very hard ones, containing animal matter which will give them a high melting point.

The advantages of grease are that when used on a bearing, the grease is used as needed and after doing its work in the bearing, forms a collar on the shaft which prevents dirt and other foreign matter from working into the bearing. When used in a gear box, the part which is next to the gear teeth is the only part which is in constant agitation, while the metal particles will have a tendency to settle to the bottom of the case. Grease is more economical than oil, is handier and will stay in place better, will not work out of the gear box and make a nasty and dangerous mess.

NOT SUITABLE FOR CYLINDER

However, greases should not, as a rule, be used as a cylinder lubricant, because they are usually rich in hydrocarbons and when burned will leave a large quantity of carbon deposit behind.

UNSUITABLE OILS

Before closing this discussion on liquid and semi-liquid lubricants, it might be well to call attention to the difference between vegetable and animal oils. Where animal oils or greases are used, there is danger of acids being formed which will attack the metal surfaces. This is particularly noticed in animal oil when used as a gas engine cylinder lubricant, because the formation of these acids is more pronounced where there is much heat. Vegetable oils as a rule are not adapted to the severe conditions that mineral oils are, and when pure are expensive.

The following very simple test will determine whether the oil contains vegetable or animal oils. If chlorine is added animal oils are indicated by a brownish appearance of the liquid, while vegetable oils will turn white.

SOLID LUBRICANTS

Under the third class of lubricants, the best one is flake graphite. It possesses all the necessary requirements as indicated above and is, in fact, a perfect lubricant. It has been found that when used with oil it will in time attach itself to all the minute irregularities which are known to exist in metal surfaces, forming a thin, tough, veneer-like coating of marvelous smoothness.

It has been found by actual test by such men as the late Professor Robert Thurston, Professor Kingsbury and others, that the co-efficient of friction is reduced very materially when from five to ten per cent. of flake graphite is used with the oils, and that a heavier load may be carried per square inch of bearing surface. These deductions are borne out by the experience of many practical men and today, when bearings give signs of distress (indicated by heating or groaning in the advance state), flake graphite always comes to the rescue.

ADVANATGES OF GRAPHITE

Possessing great natural lubricating qualities in itself, and being unaffected by wide changes of temperature, it makes an ideal lubricant for gas engine cylinders, and when used with cylinder oil it has been found that the amount of oil consumed is materially reduced, compression is increased several pounds, more heat is available for actual work in the engine, in that the temperature of the exhaust gases is reduced and smoother running is generally noted without changing the test conditions at all.—*Graphite*, January, 1911.

Short Notes

French Target Practice.—Reference has already been made in these columns to the discussion which has taken place in France concerning the competitive firing of the ships last year. The old coast defense battleship *Fulminant* was anchored in the southern passage of the Iles d'Hyerès, and was the target. The ship had been specially prepared with light plating to show a rectangle 180 feet 6 inches long and 26 feet 3 inches high. This rectangle extended the whole length of the upper works, but not to the higher portions of the superstructure, and it descended to the bottom of the armor plate below water. The firing vessels did not know the route to be taken, because it followed a vessel which guided it and received no instructions until the last moment. The course comprised a direct run and then a spiral of the University of Sheffield and appeared to show that there existed at the weld a solid solution of copper in steel, which solution was molecularly continuous with the body of the steel itself and was, moreover considerably stronger than the main body of metal, so that welds made by this method had apparently an efficiency of more than 100%.

The application of this process to the making of armor plate consists in welding thereby a thin plate of extra hard steel, such as the high-speed steel now in general use for metal-cutting tools, upon the face of a thick plate of soft, tough steel. This would give an armor plate resembling those made by the face-hardening processes in common use, with the advantage that a harder face could be applied and could be made of any desired thickness. It is reported that trials made with plates consisting of 2 inches of hard steel Simpson-welded to 4 inches of soft showed satisfactory resisting qualities. The *Times* states, however, that in spite of reports to the contrary, no Simpson armor has yet been used on a British warship.

—*Engineering News*, April 13, 1911.

The 15-inch Gun (*British*).—The statement that the Admiralty has decided to adopt the 15-inch gun, and that experiments are shortly to be made with such a weapon, is declared by *The Times* to be at least premature. For some time past designs have, *The Times* states, been got out in this country for the 15-inch and 16-inch wire wound gun, but at present no weapons of those calibers are in existence, nor have any orders for their construction been given by the Naval authorities. The statement that the 15-inch gun will be of 50 calibers in length is considered of itself a reason for doubting its reliability, as such a gun would be 62½ feet long, or about 12 feet longer than the 13.5-inch gun which is now being mounted in the *Orion* and *Lion*. There is only a difference of a few inches between the length of the 13.5-inch and the 12-inch guns of 50 calibers which it superseded, while the 14-inch guns, to which Sir Andrew Noble referred in his address to the Armstrong Company's shareholders, are only 43 or 44 calibers. In the opinion of *The Times* there is no particular reason why in this country an advance should be made at the present moment to a 15-inch gun. In the first place we have four ships in the water, and two more about to be launched, all of which will carry the 13.5-inch gun, whereas no other Power has any vessel so far advanced which will mount a heavier gun than the 12-inch. The third Brazilian ship, building at Elswick, will, it is reported, be armed with the 14-inch gun, but there are 14-inch guns made and tried in this country which could be put in British ships of war if necessary.—*Hampshire Telegraph*, April 21, 1911.

The Austro-Hungarian Dreadnoughts.—The *Zeit* publishes the following details of the dimensions and armament of the first Austro-Hungarian Dreadnought *Viribus Unitis*:—Length on water line, 151 metres (495.4 feet); greatest breadth, 27.3 metres (nearly 89 feet); mean draught, 8.2 metres (26 feet); displacement, approximately 20,000 tons. The artillery armament will consist of 12, 30.5-centimetre (12-inch) guns of 45 calibers length in four triple turrets; 12, 15-centimetre (5.9-inch) guns, also of 45 calibers length; 18, 7-centimetre (2.7-inch) guns of 50 calibers length; two 4.7-centimetre (1.7 inch) guns of 50 calibers length; two 4.7 centimetre quick-firers, two 8-millimetre machine guns, and two 7-centimetre landing guns of 18 calibers length. The *Viribus Unitis* will carry 11 searchlights and be propelled by three groups of turbine engines. There will be two funnels and two masts.—*Page's Weekly*, April 14, 1911.

The Progress of War Material in 1910—*Field Artillery.*—In the domain of field artillery the only new equipment which has appeared is the Montlucon "scissors trail" gun, invented by Colonel Deport. The gun is a 14.3-pounder, M. V., 1660 f.s., with hydro-pneumatic recoil gear of the ordinary French type. The novelty is confined to the lower carriage, which has a divided trail so constructed that the two halves can be opened out and nailed to the ground. This gives 60 degrees of traverse and 75 degrees of elevation, so that the gun can be pointed at any possible target on the ground or in the air without shifting the carriage. This gun has been successfully tried, and its mechanical action seems quite satisfactory; but it is an open question whether the tactical advantages gained are sufficient to compensate for the additional complication. The gun mould be nearly useless for firing at balloons without special smoke-trail ammunition, which could not be carried without reducing the number of rounds available for ordinary purposes, and it would appear preferable to rely on special high-velocity guns for engaging balloons and aeroplanes.—*U. S. Naval Institute Proceedings*, March, 1911.

Two New Field Howitzers.—The German howitzer trials are now concluded, and the Military Committee have selected the 4.2-inch q.f. howitzer submitted by Krupp. The new weapon is on the long-recoil system, with rear trunnions; it is 14 calibers long, has the wedge-breech action, and fires a "universal" shell (shrapnel and high explosive combined), with m.v. 985 f.s. The shell weighs 31 pounds, and has a long pointed head, with an ogive of 4 calibers. The howitzer weighs 22½ cwt. in action and 37 cwt. behind the team, with 18 rounds in the limber. It has a 4-millimeter hooded shield. This seems a light and handy weapon, but is far inferior in power and, we believe, in accuracy to our own new howitzer. The new Dutch field howitzer is also a Krupp, on similar lines to the German, but is only of 3.75-inch caliber, firing a 22 pound shell with m.v. 1,080 f.s. It weighs 20 cwt. in action and 36 cwt. behind the team, with 24 rounds in the limber. The German weapon seems by far the better of the two.

—*The Army and Navy Gazette*, February 4, 1911.

Heavy Field Guns in Austria.—The Austrians have been experimenting with a 9.4-inch siege howitzer, transported on a Daimler motor wagon of 100 horse power, capable of a speed of ten miles an hour, and the results obtained have been so good that it is now proposed to employ this weapon with the field army. The Austrians have already a 30-pounder and a 95-pounder field howitzer, but the 9.4-inch is a far more powerful weapon, throwing a 250 pound shell to a range of six miles. As we have recently noted, there is a growing tendency towards the increased employment of heavy artillery in the field. A battery of four 9.4-inch howitzers is capable of throwing eight shrapnel per minute, each containing over 4,000 bullets, and covering an area 50 yards wide by 100 yards deep. In the assault upon an entrenched position the support of such a battery would be of inestimable value.—*The Army and Navy Gazette*, April 1, 1911.

Schwarzlose Machine Gun Adopted in Holland.—The Dutch have now adopted the Schwarzlose machine gun, already in use in Austria. It is of 6.5 mm. caliber, and takes the same ammunition as the rifle. This weapon is on the power-cylinder system, the mechanism being actuated by the powder gases, of which a small portion pass through a minute hole in the barrel into the power cylinder at each round. The mounting is quite different from that used in Austria. It consists of a small sleigh, the front of which can be raised by props when it is required to fire from the kneeling position. The sleigh is carried on a light gun-carriage with limber, drawn by two cobs. The carriage is taken up as far as the available cover permits, and the machine gun on its sleigh is then taken forward by the detachment with drag-ropes. The limber carries 15,000 cartridges, and is seated for three men, so that when necessary the machine gun section, with reduced numbers, can move at a trot. The officers are mounted on cobs.

—*The Army and Navy Gazette*, April 15, 1911.

Army Ordnance Answers English Critics.—The ordnance department of the Army has just successfully completed at the Sandy Hook proving ground a series of firings with an 8-inch gun and its powder charges artificially raised to elevated temperatures, with a view to determining whether there was any foundation for the statements recently made by Sir Hiram Maxim and appearing in the public press, that the smokeless powder used by the United States Army and Navy could not be fired at temperatures as high as 150° F. without blowing up the guns. At these firings the temperatures of the gun and the powder were raised as high as 208° F., a temperature much higher than any likely to be encountered in service. The results served to completely refute Sir Hiram Maxim's charges, since no irregular or destructive pressures were encountered. The firings were made with full charges of the multi-perforated powder and with the service weight of projectile. Rounds were fired with the gun and powder at 70°, 148°, 169°, 187.5°, and 208° F. The gun was raised to the desired temperature by filling the bore with live steam while applying to the outside of the gun a cork jacket to prevent loss of heat by radiation. The powder was raised to the desired temperature by being placed in sealed containers in a steam heated compartment, where it remained several days, in order to insure every grain being raised to the desired temperature throughout its extent. The test was executed without the slightest damage to the gun or its mount. Some increase in velocity and pressure was obtained, as was to be expected, but there resulted no irregular or disastrous pressures such as were predicted by Sir Hiram Maxim. As the highest temperatures to which the gun and powder were raised were greatly in excess of any that will obtain in service, it has been demonstrated that no dangerous pressures will occur in service from any possible temperature of gun or powder, or both, when fired.—*Army and Navy Register*, March 18, 1911.

Russian Coast Defenses.—In the Russian Budget for the present year the first votes are included for the building of two new coast fortifications at the entrance to the Gulf of Finland, these being designed to forbid the passage to an enemy's fleet. The southern fortress is on a peninsula to the east of Reval, and is to receive an extraordinarily powerful armament, including twenty 12-inch and forty 9.8-inch guns, forty 7.8-inch mortars, and seventy small quick firers. Some of the heavy guns will be in armored turrets. The northern fortification is to be near Sveaborg on an island, and will not have such powerful guns as the southern fortress, but the two together will command the intervening water. The whole object is to protect the approaches to St. Petersburg, and in this connection it is interesting to note that 5,000 men are to be added to the *personnel* of the fleet, especially for the manning of three new battleships and two armored cruisers, which are to be stationed in home waters. Recently there appeared an article in the *Russki Invalid* relating to these works in which the author contended that heavy mortars were the right armament for coast fortifications. He said that guns would not be sufficiently powerful to penetrate armor at the range at which fire could be opened, that oblique hits would have comparatively little effect, and that it would be impossible to employ shells carrying more than 6 to 7 per cent. of explosive. Some of these criticisms do not appear well to apply to the new fortifications with their powerful guns. The writer considers the advantage of the mortar to be in the greater explosive effect of its shells, and the fact that they would strike a ship in her weakest point—namely, on the deck. At the same time he admitted that the ammunition would cost more, and that the rate of fire would not be so great.

—*The Army and Navy Gazette*, March 25, 1911.

Improving the Quality of Thermit Steel.—During the past year considerable time and expense has been devoted to methods for improving the quality of Thermit steel and giving a better and stronger metal in the weld. The results obtained are of very great value, and we are confident that any of our readers who are using the process for welding locomotive frames, electric motor cases, or other general repair work, will find it to their advantage to avail themselves of these improvements.

It has been the custom in the past to mix 2 per cent. of pure manganese with the Thermit in the crucible, in order to obtain a better quality of metal than could be had from the Thermit alone with no additions to it. An improvement on this, however, is to mix 1 per cent. of nickel Thermit with the iron Thermit, and 1 per cent. of pure manganese.

This gives better results than the manganese alone, but in this case the manganese should be added in lumps about the size of hazel nuts. Welds poured from this mixture will show a very fine grain.

We wish to recommend this practice to everyone engaged in Thermit welding.—*Reactions*, First Quarter, 1911.

French Service Uniform.—The official description of the new French Service dress has now been issued. The French soldier is to be dressed in grey-green uniform. He is to have a light cork helmet, but otherwise the uniform will be very similar to our own, consisting of a loose frock with four pockets, trousers, and puttees. The accoutrements consist of a brown leather belt with shoulder straps supporting a small valise of brown canvas, water-bottle, haversack and entrenching tools. Mounted troops wear breeches and "false boots"; that is, a laced boot with the leg of a jack-boot drawn down over it and secured by the spur strap. The officers' uniform will be the same as that of the men, but of finer materials. The badges of rank will be gold stars for field officers, and silver for captains and subalterns. The infantry officer's sword is to be maintained, but it is to be reduced in size so as not to get in his way when running or lying down; the scabbard will be covered with cloth. The change is generally welcomed in the army, but many infantry officers consider that since their sword is to be reduced to a toy it might as well have been abolished altogether.

—*The Army and Navy Gazette*, April 22, 1911.

Inauguration of the Railophone.—Miss Marie Corelli formally inaugurated the first "railophone" installation of wireless inductive telephony and signalling to and from moving trains at Stratford-on-Avon last week. By his system of wireless telephony Mr. von Kramer claims that it is now possible to send and receive messages of every description to and from any train, whatever the speed, or whether it is standing still in a station or along the line. A distance of some 10½ miles—from Stratford-on-Avon to Kineton—has been equipped with the system, which consists of two large frames of electric wires which are fixed round a railway coach. At a distance of several feet from the line runs a wire—which may be underground or fixed on low posts—connecting up signal boxes and stations. There is no mechanical contract between the wire and the train; the connection is "wireless," the result of electro-magnetic induction emanating from the frame fixed on one of the coaches.—*Page's Weekly*, April 28, 1911.

Tungsten-Coated Silver Lamp Filament.—In a patent issued on March 14 to Mr. Karl Farkas, New York City, a description is given of a process for producing a compound filament for incandescent lamps consisting in heating electrically a fine silver wire in a rarefied atmosphere of about 20 inches composed of about 85 per cent. of vapors of a tungsten compound, about 8 per cent. of vapors of chloride of silver and 7 per cent. of pyrogallol vapors, the result being a metal coating on the fine conductor after reduction in an atmosphere of hydrogen.—*Electrical World*, April 6, 1911.

Wireless Telegraphy.—Trials have just been made at the experimental wireless station at the Darmstadt Technical High School with an apparatus devised by Johann Sacek, of Prague, for the purpose of preventing the interception of wireless telegrams by third parties. It is claimed that the apparatus permits of the maintenance of complete secrecy, and that messages transmitted by it can only be read by the particular station for which they are intended. The invention is stated to represent extraordinary progress in wireless telegraphy.—*The Electrical Review*, March 31, 1911.

Events of Military Interest in Germany During the Month of January, 1911. —A Bavarian officer is reported to have invented a new projectile consisting of a core of steel and a mantel of aluminum with also cap and bursting charge. The advantages claimed are that penetration will be much increased and the explosive effect more disastrous. This is not a new idea, but is here noted as indicating the lines along which some inventors are working.

The Collapse of a Fort. Two Millions (of Francs) Damage.—The fort of Valaf, in the VIth sector of the first line of defense at Anvers, has just fallen in. The cupola of the St.-Chamond type, carried down by its tremendous weight, has sunk into the ground, its masonry base having slipped. A similar accident occurred recently to the Ruppelmonde fort. Fortunately, there is only material loss to be deplored; the workmen warned by a large crack, had escaped before the disaster. Orders have been given to send a company of engineer workmen to the place.—*La Belgique Militaire,* April 2, 1911.

Telephotography.—A report from Russia tells of a remarkable apparatus which would seem to combine the functions of a camera with transmission to a distance, so that the observer sees a picture of whatever is exposed to the sending apparatus. Details of the method employed are lacking, and until these are published, it is only natural to suppose that the importance and the accomplishments of the new invention have been greatly exaggerated.—*Electrical Review and Western Electrician,* April 15, 1911.

NOTICES

AMERICAN RED CROSS—INTERNATIONAL CONFERENCE

The American Red Cross announces, in connection with the International Conference of the Red Cross which will be held at Washington, D. C., in May, 1912, that the Marie Feodorovna prizes will be awarded.

These prizes, as may be remembered, represent the interest on a fund of 100,000 rubles which the Dowager Empress of Russia established some ten years ago for the purpose of diminishing the sufferings of sick and wounded in war. Prizes are awarded at intervals of five years, and this is the second occasion of this character. These prizes in 1912 will be as follows:

1 of 6,000 rubles; 2 of 3,000 rubles each; 6 of 1,000 rubles each.

The subjects decided upon for the competition are:

1. Organization of evacuation methods for wounded on the battle field, involving as much economy as possible in bearers.
2. Surgeon's portable lavatories for war.
3. Methods of applying dressings at aid stations and in ambulances.
4. Wheeled stretchers.
5. Support for a stretcher on the back of a mule.
6. Easily portable folding stretcher.
7. Transport of wounded between men of war and hospital-vessels, and the coast.
8. The best method of heating railroad cars by a system independent of steam from the locomotive.
9. The best model of a portable Roentgen-ray apparatus, permitting utilization of X rays on the battlefield and at the first aid stations.

It rests with the jury of award how the prizes will be allotted in respect to the various subjects. That is to say, the largest prize will be awarded for the best solution of any question irrespective of what the question may be.

Further information may be obtained by addressing the Chairman, Exhibit Committee, American Red Cross, Washington, D. C.

CONGRESS OF TECHNOLOGY

Beginning April 10th, a Congress of Technology was held at Boston, under the auspices of the Massachusetts Institute of Technology. A copy of *The Tech*, for that date, which we received recently, is devoted to the history of the Institute, a statement of its work and of its development, during the fifty years since its organization. The bill providing for its charter was signed April 10, 1861, but due to financial difficulties caused by the Civil War the first session began in 1865. We hope that the next fifty years may see as great an increase in usefulness to the country and to the world, as is shown by the Institute in its past fifty years of existence. We confidently predict that this will be the case.

We quote the following from the issue of *The Tech* mentioned above:

"In an article published in the *Popular Science Monthly* a few years ago, Professor George F. Swain summarized the claims of the Institute to recognition as a leader in the development of technical education as follows:—

"It was the first school in the world to institute laboratory instruction in physics and chemistry to students in large classes as a part of the regular course of each candidate for a degree; the first to equip a mining and metallurgical laboratory for the instruction of students by actual treatment of ores in large quantities, the first to establish a laboratory for teaching the uses and nature of steam, and a laboratory for testing the strength of materials of construction in commercial sizes; and the first in America to establish a department of architecture. Later still, it was the first school in America to establish distinct courses of study in electrical engineering, in sanitary engineering, in chemical engineering and in naval architecture."

THE FIELD ARTILLERY JOURNAL

We are glad to see the first number of the *Field Artillery Journal*, which has appeared for the first quarter of this year. It contains several very interesting articles among which may be mentioned, "How Can the Efficiency of Field Batteries of the Organized Militia be Increased?"; "Field Artillery Telephone, Model 1910," by Lieut. Dawson Olmstead, 5th Field Artillery; "The Care and Training of Artillery Remounts," by Major W. J. Snow, 5th Field Artillery; "The Camp of Instruction for National Guard Field Artillery Officers at Fort Riley, Kansas, June, 1910," by Capt. R. F. Tyndall, Battery A, Field Artillery, N. G. of Indiana; "Instruction of Scouts and Agents," by Lieut. Cortlandt Parker, 6th Field Artillery.

If the standard of this number is kept up—which is warranted by the character of the management—the usefulness of the *Field Artillery Journal* is assured and we predict for it a most creditable career.

EHRHARDT WAR MATERIEL

The Library of the Coast Artillery School has recently received a very complete set of catalogs showing the products of the Rheinische Metallwaaren- und Maschinenfabrik. They contain many illustrations showing the extensive shops and factories of the company, besides cuts of all the many lines of guns and carriages which they make for military and naval purposes. There is a voluminous discussion of the *Einheitsgeschosse* (single projectile) for field artillery and of the relative merits of the Ehrhardt-von Essen high-explosive shrapnel and the Krupp shell shrapnel, concerning which there has been much discussion recently. The Ehrhardt system of howitzers, mountain guns and field guns are each fully described and data concerning them given. A warm tribute is paid to the genius and high abilities of the founder of the company, Gehemier Baurat Ehrhardt, whose uphill contest against the older Krupp firm has been admired by persons cognizant of it, for many years.

MOUNTAIN AND COLONIAL ARTILLERY

Mountain and Colonial Artillery by General R. Wille, I.G.A., was reviewed in the last issue of JOURNAL U. S. ARTILLERY.

This is an exhaustive description of the principal systems of mountain artillery. The author traces the progress and development of this branch of Artillery, gives a review of the systems in use in 19 different countries, and describes the output of the principal European factories. The work comprises 187 pages, with an appendix of 16 pages, in which differential recoil is discussed. There are numerous excellent illustrations. This work would be useful to anyone interested in its subject.

RAILWAY STATISTICS OF THE U. S. OF AMERICA

In pamphlet form the Slason Thompson Bureau of Railway News and Statistics gives a vast amount of information which can not fail to be of interest to any person who cares at all for facts of economic importance to the country at large. In the introduction is a table giving data of mileage, operating costs, equipments, etc. for 1890, 1900 and 1910. Another table gives the income account of all railroads for 1889 and 1909 (1890 and 1900 figures not being available). There follows a severe arraignment of recent legislation and recent decisions of the Interstate Commerce Commission.

The following chapter headings show the scope of the pamphlet: Mileage, in 1910, Equipment, Employes, Capitalization, Cost of Construction, Ownership of American Railways, Earnings and Expenses, Taxes, Accidents, etc. At the end are some very sensible recommendations, among which we would especially commend that which advises "a genuine, expert investigation into the causes of railway accidents modelled after the British practice."

NAUTICAL TECHNICAL DICTIONARY

The *Mitteilungen aus dem Gebiete des Seewesens* has recently issued volume II, part 2 (L to Z) of their *Nautisch-techniches Worterbuch* in English, French, German and Italian. A review of this volume will be found in the last issue of the JOURNAL. The book contains English and French words arranged in one alphabet and followed by the equipment in the other of the two languages and by the equivalents in German and Italian. As far as can be judged from this volume, the work would be valuable for anyone translating any of the languages concerned.

CORRESPONDENCE

Any communication received by the Editor, which the writer desires inserted, which is signed by him and which would be of interest to the readers of the JOURNAL from a military point of view, will be published in this department. It is especially desired to have questions asked and small items of information given. Questions asked in one issue will be answered in the next, where possible, by some person, or persons, who is considered to be capable of giving authoritative information on the subject involved. Answers or remarks, regarding any such question by any others will always be very welcome. The readers of the JOURNAL (and all others interested in it or its work) are most cordially invited to make full use of this department.

RECRUITMENT OF OFFICERS*

West Point, N. Y.,
May 8, 1911.

The Editor, Journal U. S. Artillery,
Fort Monroe, Virginia.

Sir:—

The article entitled "Remarks on the Recruitment of Officers" was written a month before the publication of the recent General Order from the Adjutant-General's office, altering the requirements for appointment in the mobile army. I am delighted to find that portion of my remarks relating to the low educational standard set for these examinations, rendered obsolete even before its publication; for the new system will demand such a degree of education as our profession has a right to expect from candidates for admission to it. It is to be hoped, however, that the last step has not yet been taken toward the betterment of our scheme for the recruitment of officers. I venture to think that much may still be done to raise our standard, to give greater elasticity to requirements, to co-ordinate the numerous sets of examinations for appointment in the army, and to increase the activity of the competition for places. Suggestions as to all these points are made in the article referred to; if they serve no more than to turn one or two other officers to serious consideration of the subject, they will have had a share in the creation of the perfected system which we shall some day see.

Very respectfully,
Thomas M. Spaulding,
1st Lieutenant, Coast Artillery Corps.

---

* This refers to the article under this title beginning on page 262 of this JOURNAL. It was in press before the General Order referred to was issued and before the above communication was received.—EDITOR

NOTES AND TABLES FROM C. A. D. R.

The Editor, Journal U. S. Artillery,
Fort Monroe, Virginia.

Dear Sir:—

I send you some notes and tables which were very useful to me as instructor in Coast Artillery Drill Regulations. I thought that they might be useful to others under similar circumstances.

Yours very truly,
H. S. Brown,
Captain, Coast Artillery Corps.

SIMILARITY OF DUTIES OF NUMBERS SERVING AT COAST DEFENSE GUNS

The principal variations in detail are due to the weight of the projectile and powder charge and the mount, and affect the duties of the breech and the rammer details. The following outline shows the similarity of drills, the principal exceptions in the various duties of the numbers being noted.

Gun Pointer.—Same for all guns—except for Disappearing Carriage gun cannot be traversed when truck is against breech while for Barbette it can. At 6-pounder and 3-inch, he also directs clamping. At mortars, duties are entirely different.

Range Setter.—Same for all guns (not 6-inch) except barbette must be depressed 1° 15′ for loading and unloading, which necessitates a new setting for each firing and a command "Range Set." At 3-inch guns he also clamps.

Chief of Breech Detail.—Same for all guns (not at 8-inch and smaller) except he does not handle lanyard at 10-inch D. C.; and for barbette, he assists in ramming and passes lanyard to No. 4, and also omits command "In Battery—TRIP."

Azimuth Setter.—For mortars only.

Elevation Setter.—For mortars only.

NUMBERS HANDLING POWDER

Section.	12″ D.C.	10″ D. C.	8″ D. C.	12″ B.	10″ B.	All other pieces.
1	12	12	12	2	2	2
2	11	1		1	1	
3	2			2		
4	11			1		

NUMBERS RAMMING PROJECTILE

12″ Mor.:	G. P., 1-2-4-5	
12″ D.C.:	1-2-4-	9-10-16-18
10″ D.C.:	1-2-4-	9-10
8″ D.C.:	1-2-4-	9-10
12″ Bar.:	1-2-4-	-16
10″ Bar.:	1-2-4-	
8″ Bar.:	1-2-4-	
6 Inch.:	4-	

No. 1.—Same for all guns except as shown above and performs duties of chief of breech detail, when none assigned. He also fires 8″ barbette.

No. 2.—Same for all guns except as shown in preceding tables.

No. 3.—Same except for 12″ D.C. and Barb. does not unhook lanyard. He fires D.C. but not Barbette.

No. 4.—Same for all D.C. guns. At 12″ and 10″ barbette he wipes breechblock, oils threads, dismounts and fires, and also does not bring up rammer.

Nos. 5 and 6.—Same for all guns of primary armament. Projectile detail for intermediate. No. 6 in charge of powder detail for mortars.

Nos. 7 and 8.—Same for all guns of primary armament except at D.C. guns halts when piece is fired and at 10″ and 8″ D.C. No. 8 receives muzzle cover from No. 11. Powder detail for intermediate guns. Truck detail for mortars.

Nos. 9 and 10.—Same except at D.C. guns they assist in ramming and trip; at barbette they assist at hoist tackle. Truck detail at mortars.

No. 11.—Same except removes muzzle cover and assists No. 9 at 10″ and 8″ D.C.

No. 12.—Same.—Note: For barbette, trucks are run to hoist tackle, and duties prescribe a loaded truck under tackle practically all the time.

Nos. 13, 14 and 15.—Same for all guns.

No. 16.—At 12″ D.C. and 12″ Barb. and 10″ Barb. only. Does not mount platform of 10″ Barb.

No. 17.—At 12″ D.C. opens breech of Stockett mechanism, otherwise performs ramming duties prescribed for No. 1 and assists him on translating crank if necessary.

At 10″ and 12″ Barb. examines and cleans hoisting gear tackle and assists in hoisting projectile.

No. 18.—At 12″ D.C. and 12″ and 10″ Barb. Duties same except at D.C. guns assists in ramming and at barbette assists in hoisting projectile.

TABULATED STATEMENT OF NUMBER OF MEN REQUIRED TO MAN EMPLACEMENTS.

			Gun Section.		Approximate Ammunition Section.			
No.	Caliber.	Officers.	N. C. O.	Other Enlis'd Men.	N. C. O.	Other Enlis'd Men.	Mechanic.	Total Etlis'd Men.
1	12″ D. C.	1	1	21	1	15	1	39
1	12″ Barb.	1	1	21	1	15	1	39
1	10″ Barb.	1	1	21	1	11	1	35
1	8″ Barb.	1	1	21	1	9	1	33
1	10″ D. C.	1	1	18	1	11	1	31
1	8″ D. C.	1	1	16	1	10	1	29
1	6″ D. C.	1 (2)	1	11	1	6	1	20
1	6″ Ped.	1 (2)	1	11	1	6	1	20
1	5″ Ped.	1 (2)	1	11	1	6	1	20
1	4.7″	1 (2)	1	11	1	6	1	20
1	4 Inch.	1 (2)	1	11	1	6	1	20
1	3 Inch.	1 (2)	1	5	1	6	1	14
1	6 Pdr.	1 (B.C.)	1	7	-	-	-	8
4	12″ Mor.	1	1	52	1	30	2	86

Telephone, telautograph, orderly, time range relation board and similar details not included. They are considered as fire control details.

TABULATED DETAILS OF GUN AND MORTAR SECTIONS IN U. S. COAST ARTILLERY SERVICE.

Caliber.	Special.			Breech.	Rammer.	Elevating.	Traversing.	Tripping.	Hoist Tackle.	Truck.	Hoist.	Projectile.	Powder.	Ammunit'n.	Extractor.	Clamp.	Charge.
12" D. C.	G. C.	G. P.	R. S.	Chief-1-2-3-17	4-16-18	5-6	7-8	9-10		11-12	†13-14-15						
12" Barb.	G. C.	G. P.	R. S.	Chief-1-2-3	4-16	5-6	7-8		*9-10-17-18	11-12	†13-14-15						
10" Barb.	G. C.	G. P.	R. S.	Chief-1-2-3	4-16	5-6	7-8		*9-10-17-18	11-12	†13-14-15						
8" Barb.	G. C.	G. P.	R. S.	*1-2-3	4	5-6	7-8		*9-10	11-12	†13-14-15						
10" D. C.	G. C.	G. P.	R. S.	Chief-1-2-3	4	5-6	7-8	9-10		11-12	†13-14-15						
8" D. C.	G. C.	G. P.	R. S.	*1-2-3	4	5-6	7-8	9-10		11-12	†13-14						
6" D. C.	G. C.	G. P.	R. S.	*1-2-3	4			9				5-6	7-8				
6" Ped.	G. C.	G. P.	R. S.	*1-2-3	4							5-6	7-8				
3" Ped.	G. C.	G. P.	R. S.	1-2											3		
5" Inch. 4.7" 4 Inch.	Sections and details arranged along lines of 6" or 3" as may be most applicable, but organization at emplacement same as that for a 6" Gun Battery (Pedestal Mount)																
6 Pdr.	G. C.	G. P.		1-2			3			7-8-9-10				5-6		4	
Mortars.	G. P.	A. S.	E. S.	*1-2-3-4	4	5											6

G. C.—Gun Commander.
G. P.—Gun Pointer.
R. S.—Range Setter.
A. S.—Azimuth Setter.
E. S.—Elevation Setter.

*Designated as Chief.

†Designated as Chief unless a non-commissioned officer is assigned.

Compiled from Chapter III, Coast Artillery Drill Regulations, 1909.

TABLE SHOWING DETAILS NECESSARY FOR MANNING FIRE CONTROL SYSTEM.

No.	Two Gun Battery—Primary Armanent.	Mortar Battery.	Fire Command.	Mine Command.	Battle Command.	Miscellaneous.
			4 Battys. 1 S. L. No E′ No Tel. Swicthboard. Plotting Board.	1 R. F. Battery. Single M′ and M″ No E′	6-F′. 2-M′. 4 S.L.	
1	Battery Commander	Battery Commander	Fire Commander	Mine Commander	Battle Commander	S'chl't Op. Cent. Pl't
2	Range Officer	Asst. Batty. Com'der	Communica'n Officer	Asst. Mine Comm'dr	Communicat'n Officer	1. Operator
3		Range Officer			Searchlight Officer	2. Assistant
1	Observer B.C.	Observer B.C.	Electrician Sergeant	Searchlight Operator	Master Electrician	3. Watcher
2	Observer B′	Observer B′	Observer F′	Observer M′	Observer	4. Telephone Oper'tr
3	Observer B″	Observer B″	Observer F″	Observer M″	Reader	5. Engineer
4	Observer E	Observer E		Op. Tele. Casm-Post	Operator Tel. F′ 1	6. Fireman
5	Asst. Observer E	Asst. Observer E		Op. Tele. Casmate M′	Operator Tel. F′ 2	7.
6	Reader B′	Reader B′	Reader F′	Reader M′	Operator Tel. F′ 3	1. Obsvr. Tide Stat.
7	Reader B″	Reader B″	Reader F″	Reader M″	Operator Tel. F′ 4	2. Obsvr. Mtrl. Stat.
8	Plotter	Plotter	Plotter	Plotter	Operator Tel. F′ 5	3. Obsvr. Sgnl. Stat.
9	Asst. Plotter	Assistant Plotter	Assistant Plotter	Assistant Plotter	Operator Tel. F′ 6	4. Asst. Obs. S. Stat.
10	Arm Setter	Arm Setter	Arm Setter	Arm Setter	Operator Tel. M′ 1	5. Op. Wireless Stat.
11	Arm Setter	Arm Setter	Arm Setter	Arm Setter	Operator Tel. M″ 2	6. Op. Post Sw'board
12	Range Computer		Op'tr S.L. Controller		Orderly	7. Asst. Op. Sw'brd
13	Deflection Computer	Azimuth Computer	Operator Post Tele.	Operator Post Tele.	Orderly	8. Op. Sw'brd Room
14	Musician	Musician	Orderly	Orderly	Orderly	.9. Engineer Cnt. Plt.
15	Telautog'h Operator	Op'tr Indic. Device	Op'tr Tel. Battery A	Op'tr. Tele. Battery	Operator S.L.C. 1	10. Fireman Cnt. Plt.
16	Operator Tel. to F′	Operator Tel. to F′	Op'tr Tel. Battery B	Op'tr. Tele. Casem'te	Operator S.L.C. 2	11. Asst. Cent. Plant
17	Operator Tel. to B.C.	Op'tr Tel. to Pit B.C.	Op'tr Tel. Battery C	Casem'te Elec. No. 1	Operator S.L.C. 3	
18	Range Keeper No. 1	Op'tr Tel. B.C. Pit.	Op'tr Tel. Battery D	Casem'te Elec. No. 2	Operator S.L.C. 4	
19	Range Keeper No. 2	Azimuth Keeper B.C.	Operator Tele. C	Operator Tele. C	Operator Tele. Post	
20	Recorder B′	Recorder at Booth	Recorder	Recorder	Rec'r Op'tr. Tel. Pst.	

Compiled from Coast Artillery Drill Regulations and Coast Artillery Memorandum No. 4, 1909.

RHODE ISLAND COAST ARTILLERY RESERVES

Fort Logan, Colorado,
April 23, 1911.

The Editor, Journal U. S. Artillery,
Fort Monroe, Virginia.

Sir:—

I have read with much interest that article by Captain A. P. S. Hyde, in the March-April number of the JOURNAL, on the subject of "Instruction for Coast Artillery Corps, Rhode Island National Guard." Captain Hyde is a New Yorker, and I am sure that his praise of the work of the Rhode Island troops will be appreciated by them.

The interest manifested by the Rhode Island troops is due to history, tradition, and mechanical training. I have never known of a more sincere military spirit than exists in that State, and has existed back to the time of General Nathaniel Greene. Rhode Islanders have always had a leaning toward the red stripes of the artillery. During the Civil War many light batteries were sent out from the old armory on Benefit Street. In fact the number was all out of proportion to the size of the State. The proudest boast of Weeden's, Arnold's, and Allen's batteries was that they could hold their own with the regulars, and history shows that they did on many hard-fought fields. Major Harry Cushing, well known in the old artillery, got his start in a R. I. battery. Just at present Captain Ralph S. Hamilton, a Pennsylvania Military College graduate is in command of Battery "A." He and his officers expect to go to Fort Riley this summer for a little experience with the regulars. Major General Sanger once told the writer, in speaking of Captain Weaver, the former commander of Battery "A," that he had never seen a regular battery commander, who took better care of his horses. This was not strange, for Captain Weaver owned every animal himself, and during fifty weeks of the year employed them on the less warlike duty of teaming.

Some years ago the writer happened to be in Providence. The new field artillery equipment had just been received by Battery "A". Obedient to tradition young Crawford Allen, son of Captain Allen, of Allen's Battery in the Rebellion was, as a private, engaged in the work or setting up the new pieces. Now a little job like that does not worry men who spend several hours each day in machine shops, such as Brown & Sharpe's. In our own battery, if we broke a small part of a breech mechanism, one of the section could generally turn out one on a lathe, before the next drill night, and it was seldom necessary to bother the Captain over such trifles. Allen was overjoyed, when I loaned him my new Field Artillery Drill Regulations. Since that time regular instructors have helped this battery to a better knowledge of the panoramic sight, and other complicated material.

The purpose of these few observations is simply to illustrate, in some small way, the ambitions of the national guardsman, the difficulties which he encounters, and the results, which, by perseverance, he is able to accomplish. These men spend their holidays in rifle shooting and practice marches, and their annual vacation in camps of instruction. What pay is received is not infrequently turned in to the company fund for winter entertainments.

When the Civil War broke out, Burnside was manufacturing breechloading rifles in Rhode Island. When the 1st R. I. went out in 1861, Governor Sprague led it in person to the battlefield. There is the same spirit there now. Adjutant General Sackett, who has recently retired, was wounded at Chancellorsville, while in command of Battery "C," 1st R. I. Light Artillery. The new Adjutant General is Major Charles W. Abbot, U.S.A. (retired), late of the 12th Infantry, who led out the 1st Rhode Island in 1898, as its colonel.

I trust that the readers of this magazine will pardon a little justifiable pride in the fact that my native state is acquitting itself so well, and that these few lines may inspire in some of our newer officers a greater respect for the National Guard, and instill in them a willingness to help our citizen soldiery to a knowledge of the things, with which we of the regular establishment have so much greater an opportunity to become familiar.

Very respectfully,
G. A. Taylor,
Captain, Coast Artillery Corps.

✦ ✦ ✦

MANUAL FOR ORDNANCE OFFICERS

Headquarters, Artillery District of the Columbia,
Fort Stevens, Oregon.
May 11, 1911.

Editor, Journal U. S. Artillery,
Fort Monroe, Va.

Dear Sir:—

I enclose copies of two letters which explain themselves. You will see that what I am seeking is discussion of their subject matter. The JOURNAL will reach many persons not on my mailing list and I would therefore appreciate anything you may be able to do to promote such discussion.

Yours very truly,
Mark L. Ireland,
1st Lieut., Coast Artillery Corps,
Ordnance Officer.

Headquarters, Artillery District of the Columbia,
Office of the District Ordnance Officer,
Fort Stevens, Oregon,
December 6, 1910.

The Ordnance Officer,
....
....

Sir:—

1. I have the honor to inform you that 2nd Lieut. Frank D. Applin, C.A.C., U.S.A., and the undersigned have undertaken the preparation of A Manual for Post and District Ordnance Officers."

2. It is desired that this manual shall represent the consensus of opinion and the general practice of ordnance officers, rather than the personal views of its compilers, particularly in that part of the field not covered by existing orders or regulations. Your hearty co-operation in the way of suggestion and criticism is solicited. Any copies of written instructions, printed forms,

or systems, such as instructions for armament caretakers, methods of conducting and filing correspondence, of running repair shops, schemes for the division of work among personnel, or for systematizing and reducing the routine work, which you may have, would be appreciated.

3. The scheme of the manual will be similar to the excellent Officer's Manual recently published by Captain J. A. Moss, 24th Infantry. It is proposed to have chapters on the duties of the district ordnance officer, the post ordnance officer, the district ordnance sergeant, the post ordnance sergeant, the clerk, the resident and the armament machinists, the storekeeper, the armament caretakers, and the care of armament at subposts, also chapters on returns, requisitions, correspondence, inspections, and the district repair shop. A tabulation of the reports, returns, and other papers which are required to be rendered periodically will also be included.

4. A tentative draft will be submitted on March 30, 1911 as post graduate work for the present school season. As the time is limited for assimilating and compiling the data and information which may be offered, an early reply hereto would be appreciated. Acknowledgement will be cheerfully given for any assistance rendered.

Very respectfully,
Mark L. Ireland,
1st Lieut., Coast Artillery Corps,
Ordnance Officer.

Headquarters, Artillery District of the Columbia,
Office of the Ordnance Officer,

Fort Stevens, Oregon,
December 27, 1910.

The Ordnance Officer,
....
....

Sir:—

1. I have the honor to enclose herewith a copy of the circular letter sent to all district ordnance officers, to all coast artillery post ordnance officers and to all post ordnance officers of inland posts where the garrison is as large as one regiment.

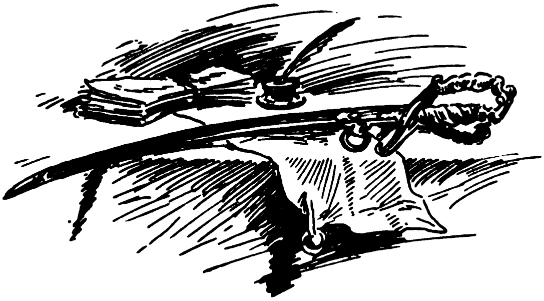
2. From occasional replies already received it seems that the purpose of the compilers had not been made clear. The object is to make of record for the benefit of the inexperienced, in whatever capacity he may find himself, the duties, responsibilities and initiative expected of him and to lay before him approved methods of doing his work in matters that are not now covered by regulations and in other cases where the regulations are scattered or obscure, to compile and make them available.

3. With your permission it is desired to submit to you from time to time tentative drafts of such portions of the text as you may be willing to criticize. The text will be mimeographed in such a way that the criticisms can be written opposite the paragraph affected. If you should be willing to afford this work the benefit of your experience, kindly indicate below what parts of the text should be sent you:

The District Ordnance Officer.

The Post Ordnance Officer.
  a. His duties which do not pertain to seacoast and land defense armament.
  b. His duties with reference to seacoast and land defense armament.
The District Ordnance Sergeant.
The Post Ordnance Sergeant.
  a. His duties which do not pertain to seacoast and land defense armament.
  b. His duties with reference to seacoast and land defense armament.
The Clerk.
The Storekeeper.
Armament Caretakers.
The Resident Machinist and Armament Machinists.
Inspections.
Reports, returns, and papers rendered periodically.
Correspondence.
Property papers.

Very respectfully,
Mark L. Ireland,
1st Lieut., Coast Artillery Corps,
Ordnance Officer.



BOOK REVIEWS

Tactics, Vol. I. Introduction and Formal Tactics of Infantry. By Balck, Colonel, German Army. Translated by 1st Lieut. Walter Krueger, 23d Inf., U. S. A., Instructor, Army Service Schools, Fort Leavenworth, Kansas. Fort Leavenworth, Kansas: U. S. Cavalry Association. 6 x 8¾. xix + 539 pp. 54 il. Cloth. 1911. Price, $3.00.

This, the 4th edition of this standard work, has been completely revised by the author and is today incontestably the latest and most valuable treatise on this subject to be found in any language. Moreover the very difficult task of translating technical German into clear English phraseology has been admirably accomplished by Lieut. Krueger, to whom not only the United States Army, but everybody in the English-speaking world interested in military matters, should be under obligation. It is greatly to be wished that the translator will continue the work and favor us with an English rendition of the remaining volumes.

The treatise is a deductive exposition of the subject of tactics, as distinguished from the applicatory system now in general use in our service schools, to which it forms a useful and necessary complement. It should not replace the applicatory method of instruction, but should be carefully read prior to, or concurrently with, the study of tactics by this method.

The work not only gives what is considered the best tactical methods as practised in the German army, but quotes extensively from the regulations and military literature of other nations, and illustrates each point by historical examples,—the South-African and the Manchurian campaigns being the ones most often cited.

We have not space for extensive citations, but the following, chosen almost at random, will illustrate the perspicuity of the text. Referring to the settlement of disputes by arbitration, Balck says:

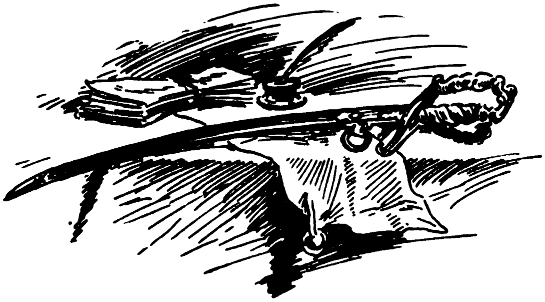
> "The utopian plans for a universal international court of arbitration are chimerical and conjured up by idealists unaccquaintd with the harsh facts of reality, if their ideas are not, indeed—as are many proposals for disarmament—calculated to serve as a cloak for ambitious plans. If diplomatic means do not suffice to adjust a dispute, then the question of right between two states at once becomes a question of might. * * "

Discussing the subject of drill regulations, he deprecates the necessity for continually changing them, but adds:

> "It is a marked peculiarity of manuals of instruction that no matter with what far-sightedness such regulations may have been originally compiled, they become antiquated in a comparatively short time. Napoleon estimated this period at ten years. * * * It is always dangerous to be behind the times, as troops thereby relinquish a superiority previously possessed over others, which knowledge they must later purchase with streams of blood, in the face of hostile bullets. * * * The war experiences of our regiments show that bullets quickly write a new tactics, demolish superannuated formations, and create new, ones. But at what a sacrifice!"

The Post Ordnance Officer.
  a. His duties which do not pertain to seacoast and land defense armament.
  b. His duties with reference to seacoast and land defense armament.
The District Ordnance Sergeant.
The Post Ordnance Sergeant.
  a. His duties which do not pertain to seacoast and land defense armament.
  b. His duties with reference to seacoast and land defense armament.
The Clerk.
The Storekeeper.
Armament Caretakers.
The Resident Machinist and Armament Machinists.
Inspections.
Reports, returns, and papers rendered periodically.
Correspondence.
Property papers.

Very respectfully,
Mark L. Ireland,
1st Lieut., Coast Artillery Corps,
Ordnance Officer.



BOOK REVIEWS

Tactics, Vol. I. Introduction and Formal Tactics of Infantry. By Balck, Colonel, German Army. Translated by 1st Lieut. Walter Krueger, 23d Inf., U. S. A., Instructor, Army Service Schools, Fort Leavenworth, Kansas. Fort Leavenworth, Kansas: U. S. Cavalry Association. 6 x 8¾. xix + 539 pp. 54 il. Cloth. 1911. Price, $3.00.

This, the 4th edition of this standard work, has been completely revised by the author and is today incontestably the latest and most valuable treatise on this subject to be found in any language. Moreover the very difficult task of translating technical German into clear English phraseology has been admirably accomplished by Lieut. Krueger, to whom not only the United States Army, but everybody in the English-speaking world interested in military matters, should be under obligation. It is greatly to be wished that the translator will continue the work and favor us with an English rendition of the remaining volumes.

The treatise is a deductive exposition of the subject of tactics, as distinguished from the applicatory system now in general use in our service schools, to which it forms a useful and necessary complement. It should not replace the applicatory method of instruction, but should be carefully read prior to, or concurrently with, the study of tactics by this method.

The work not only gives what is considered the best tactical methods as practised in the German army, but quotes extensively from the regulations and military literature of other nations, and illustrates each point by historical examples,—the South-African and the Manchurian campaigns being the ones most often cited.

We have not space for extensive citations, but the following, chosen almost at random, will illustrate the perspicuity of the text. Referring to the settlement of disputes by arbitration, Balck says:

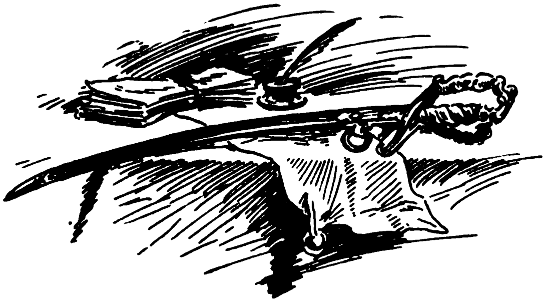
> "The utopian plans for a universal international court of arbitration are chimerical and conjured up by idealists unaccquaintd with the harsh facts of reality, if their ideas are not, indeed—as are many proposals for disarmament—calculated to serve as a cloak for ambitious plans. If diplomatic means do not suffice to adjust a dispute, then the question of right between two states at once becomes a question of might. * * "

Discussing the subject of drill regulations, he deprecates the necessity for continually changing them, but adds:

> "It is a marked peculiarity of manuals of instruction that no matter with what far-sightedness such regulations may have been originally compiled, they become antiquated in a comparatively short time. Napoleon estimated this period at ten years. * * * It is always dangerous to be behind the times, as troops thereby relinquish a superiority previously possessed over others, which knowledge they must later purchase with streams of blood, in the face of hostile bullets. * * * The war experiences of our regiments show that bullets quickly write a new tactics, demolish superannuated formations, and create new, ones. But at what a sacrifice!"

The Post Ordnance Officer.
  a. His duties which do not pertain to seacoast and land defense armament.
  b. His duties with reference to seacoast and land defense armament.
The District Ordnance Sergeant.
The Post Ordnance Sergeant.
  a. His duties which do not pertain to seacoast and land defense armament.
  b. His duties with reference to seacoast and land defense armament.
The Clerk.
The Storekeeper.
Armament Caretakers.
The Resident Machinist and Armament Machinists.
Inspections.
Reports, returns, and papers rendered periodically.
Correspondence.
Property papers.

Very respectfully,
Mark L. Ireland,
1st Lieut., Coast Artillery Corps,
Ordnance Officer.



BOOK REVIEWS

Tactics, Vol. I. Introduction and Formal Tactics of Infantry. By Balck, Colonel, German Army. Translated by 1st Lieut. Walter Krueger, 23d Inf., U. S. A., Instructor, Army Service Schools, Fort Leavenworth, Kansas. Fort Leavenworth, Kansas: U. S. Cavalry Association. 6 x 8¾. xix + 539 pp. 54 il. Cloth. 1911. Price, $3.00.

This, the 4th edition of this standard work, has been completely revised by the author and is today incontestably the latest and most valuable treatise on this subject to be found in any language. Moreover the very difficult task of translating technical German into clear English phraseology has been admirably accomplished by Lieut. Krueger, to whom not only the United States Army, but everybody in the English-speaking world interested in military matters, should be under obligation. It is greatly to be wished that the translator will continue the work and favor us with an English rendition of the remaining volumes.

The treatise is a deductive exposition of the subject of tactics, as distinguished from the applicatory system now in general use in our service schools, to which it forms a useful and necessary complement. It should not replace the applicatory method of instruction, but should be carefully read prior to, or concurrently with, the study of tactics by this method.

The work not only gives what is considered the best tactical methods as practised in the German army, but quotes extensively from the regulations and military literature of other nations, and illustrates each point by historical examples,—the South-African and the Manchurian campaigns being the ones most often cited.

We have not space for extensive citations, but the following, chosen almost at random, will illustrate the perspicuity of the text. Referring to the settlement of disputes by arbitration, Balck says:

> "The utopian plans for a universal international court of arbitration are chimerical and conjured up by idealists unaccquaintd with the harsh facts of reality, if their ideas are not, indeed—as are many proposals for disarmament—calculated to serve as a cloak for ambitious plans. If diplomatic means do not suffice to adjust a dispute, then the question of right between two states at once becomes a question of might. * * "

Discussing the subject of drill regulations, he deprecates the necessity for continually changing them, but adds:

> "It is a marked peculiarity of manuals of instruction that no matter with what far-sightedness such regulations may have been originally compiled, they become antiquated in a comparatively short time. Napoleon estimated this period at ten years. * * * It is always dangerous to be behind the times, as troops thereby relinquish a superiority previously possessed over others, which knowledge they must later purchase with streams of blood, in the face of hostile bullets. * * * The war experiences of our regiments show that bullets quickly write a new tactics, demolish superannuated formations, and create new, ones. But at what a sacrifice!"

The Post Ordnance Officer.
  a. His duties which do not pertain to seacoast and land defense armament.
  b. His duties with reference to seacoast and land defense armament.
The District Ordnance Sergeant.
The Post Ordnance Sergeant.
  a. His duties which do not pertain to seacoast and land defense armament.
  b. His duties with reference to seacoast and land defense armament.
The Clerk.
The Storekeeper.
Armament Caretakers.
The Resident Machinist and Armament Machinists.
Inspections.
Reports, returns, and papers rendered periodically.
Correspondence.
Property papers.

Very respectfully,
Mark L. Ireland,
1st Lieut., Coast Artillery Corps,
Ordnance Officer.

BOOK REVIEWS

Tactics, Vol. I. Introduction and Formal Tactics of Infantry. By Balck, Colonel, German Army. Translated by 1st Lieut. Walter Krueger, 23d Inf., U. S. A., Instructor, Army Service Schools, Fort Leavenworth, Kansas. Fort Leavenworth, Kansas: U. S. Cavalry Association. 6 x 8¾. xix + 539 pp. 54 il. Cloth. 1911. Price, $3.00.

This, the 4th edition of this standard work, has been completely revised by the author and is today incontestably the latest and most valuable treatise on this subject to be found in any language. Moreover the very difficult task of translating technical German into clear English phraseology has been admirably accomplished by Lieut. Krueger, to whom not only the United States Army, but everybody in the English-speaking world interested in military matters, should be under obligation. It is greatly to be wished that the translator will continue the work and favor us with an English rendition of the remaining volumes.

The treatise is a deductive exposition of the subject of tactics, as distinguished from the applicatory system now in general use in our service schools, to which it forms a useful and necessary complement. It should not replace the applicatory method of instruction, but should be carefully read prior to, or concurrently with, the study of tactics by this method.

The work not only gives what is considered the best tactical methods as practised in the German army, but quotes extensively from the regulations and military literature of other nations, and illustrates each point by historical examples,—the South-African and the Manchurian campaigns being the ones most often cited.

We have not space for extensive citations, but the following, chosen almost at random, will illustrate the perspicuity of the text. Referring to the settlement of disputes by arbitration, Balck says:

> "The utopian plans for a universal international court of arbitration are chimerical and conjured up by idealists unaccquaintd with the harsh facts of reality, if their ideas are not, indeed—as are many proposals for disarmament—calculated to serve as a cloak for ambitious plans. If diplomatic means do not suffice to adjust a dispute, then the question of right between two states at once becomes a question of might. * * "

Discussing the subject of drill regulations, he deprecates the necessity for continually changing them, but adds:

> "It is a marked peculiarity of manuals of instruction that no matter with what far-sightedness such regulations may have been originally compiled, they become antiquated in a comparatively short time. Napoleon estimated this period at ten years. * * * It is always dangerous to be behind the times, as troops thereby relinquish a superiority previously possessed over others, which knowledge they must later purchase with streams of blood, in the face of hostile bullets. * * * The war experiences of our regiments show that bullets quickly write a new tactics, demolish superannuated formations, and create new, ones. But at what a sacrifice!"

Upon the moral effect of fire he says:

> "We must not forget that our modern personnel has become much more susceptible to the impressions of battle. * * * The fast manner of living at the present day undermines the nervous system, the fanaticism and the religious and national enthusiasm of a bygone age are lacking, and finally the physical powers of the human species are also partly diminishing. * * * In addition, the nerve-wracking impressions of the battlefield are much greater at present than in the past. The "*void of the battlefield*" has become especially pronounced since the introduction of smokeless powder. The invisibility of the enemy directly affects the morale of the soldier, the sources of his energy, and his courage. The soldier, who cannot see his enemy, is inclined to see him everywhere. It is but a step from this impression to hesitancy, and then to fear."

The work is replete with data tabulated from the experience of German and foreign schools of fire, etc., from which tactical formations and operations under various conditions are deduced and illustrated with great clearness.

The book is well printed, and illustrated with numerous diagrams and photo cuts, but is unnecessarily large and clumsy. By using thinner paper, reducing margins, and employing flexible leather binding, the bulk of the present volume could be reduced by thirty per cent. and the book be much more serviceable. It is hoped that this improvement will be made in future editions.

Bone and Hoof Diseases of the Horse. Eighth Edition. By Colonel Von Spohr, Retired, I. G. A. Leipzig: Arwed Strauch, Verlagsbuchhandlung Oststr. 9. 6 x 8½. xvii.+204 pp. 6 il. 1910. Price, 3M.

The eighth edition of "Diseases of the Leg and Hoof of the Horse" by Colonel Spohr, retired, has recently been published by Arwed Strauch, Leipzig, Germany. The author goes into the origin, prevention, and cure of this disease, without the use of medicines. There is also an appendix on the curing in like manner, of injuries received from bruises and wounds. The first section of the book is devoted to the principles, means and forms of the natural curative methods as well as the usual errors which may arise in their application. It includes their extent and nature, embracing interior remedies, such as special food and drink, fresh air and exterior means such as the application of water, steam, massage, etc. The second section is taken up with the diseases which arise in the fore as well as in the hind legs. The third section is on the hoof and its diseases. The fourth section treats the diseases which arise only in the fore legs, while the fifth section discusses the diseases which are peculiar only to the hind legs. The appendix forms the conclusion of the book.

The author treats all possible cases which are liable to occur in the line indicated above, and speaks from an experience and observation extending over a period of sixty years. He deplores the tendency toward the too frequent use of medicines for sick horses, and firmly believes that better results are obtained by natural means with rational care and treatment. The book is well written and a valuable asset for all those interested.

INDEX

TO

CURRENT MILITARY LITERATURE

Cumulated semi-annually, in last number of each volume.

PERIODICALS CITED

All the periodicals are preserved in the Library, Coast Artillery School, Fort Monroe, Va.

AUSTRIA.

A—1 Mitteilungen aus dem Gebiete des Seewesens. *Monthly*
Pola. *Per year 17 M*

A—2 Mitteilungen ueber Gegenstaende des Artillerie-und Genie-Wesens.
Getreidemarkt 9, *Monthly*
Wien VI. *Per year 20 M*

A—3 Streffleurs Militaerische Zeitschrift. *Monthly*
zugleich Organ der militaerwissenschaftlichen Vereine.
I. Graben, 13. Wien. *Per year 28 M*

A—4 Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereine.
Eschenbachgasse, No. 9. *Weekly*
Wien I. *Per year 34 K*

ENGLAND.

E—1 Arms and Explosives. *Monthly*
Effingham House, *Per year 7 s*
Arundel Street, Sutrad, London, W.C.

E—2 Army and Navy Gazette. *Weekly*
22 Essex Street, Strand, *Per year £1 12s 6d*
London, W.C.

E—3 Canadian Military Gazette. *Semi-monthly*
Room 16, Trust Bldg., *Per year $2.50*
Ottawa, Canada.

E—3a Electrician, The. *Weekly*
1, 2 and 3, Salisbury Court, Fleet Street, *Per year 30s*
London, E. C.

E—3b Electrical Review. *Weekly*
4, Ludgate Hill, *Per year £1 10s*
London, E. C.

E—4 Engineer, The. *Weekly*
33 Norfolk Street, Strand, *Per year £1 16s*
London, W.C,

E—5	**Engineering.** *35-36 Bedford Street, Strand,* *London, W.C.*	*Weekly* *Per year £1 16s*
E—6	**Iron & Coal Trades Review, The.** *165 Strand, London, W. C.*	*Weekly* *Per year 27s*
E—7	**Journal of the Royal Artillery.** *Woolwich, England.*	*Monthly* *Single copy 2s 6d*
E—7a	Journal and Proceedings **Royal Society N.S.W.** *5 Elizabeth St., North Sydney, N. S. W.*	
E—8	**Journal of the Royal United Service Institution.** *Whitehall, London, S.W.*	*Monthly* *Per year 24s*
E—9	**Journal of the United Service Institution of India.** *Simla, India.*	*Quarterly* *Per year $2.50*
E—9a	**Military Engineering Abstracts.** *International Institute of Technical Bibliography,* *57-58 Chancery Lane, London, W. C.*	*Fortnightly.* *Per year 24s*
E—10b	**Motor Union Journal, The.** *The Motor Union of Great Britain and Ireland,* *Caxton House, Westminster, London, W. C.*	
E—10a	**National Defense Magazine.** *15 Pall Mall, East, London, S. W.*	*Quarterly* *Single copy 2s 6d*
E—11	**Page's Weekly.** *22 Henrietta Street, Covent Garden,* *London, W.C.*	*Weekly* *Per year 10s*
E—12	**Photographic Journal.** *66 Russell Square, London.*	*Monthly* *Per year 12s*
E—12a	**Proceedings of the Aldershot Military Society.** *Aldershot, England.* *Messrs. Hugh Rees, Ltd., 119 Pall Mall,* *London, S. W., Eng.*	*Occasional* *Copies 6d each*
E—12b	**Proceedings of the Institution of Civil Engineers.** *Great George St., Westminster, London, S. W., Eng.*	
E—13	**Proceedings of the Institution of Mechanical Engineers.** *Storey's Gate, Westminster, London, S. W.*	
E—13a	**Rifleman, The.** *Society of Miniature Rifle Clubs,* *20 Bucklersbury, London, E. C.*	*Weekly* *Per year 6s 6d*
E—14	**Royal Engineers Journal, The.** *Chatham, England.*	*Monthly* *Per year 15s*
E—14a	**Royal Military Society of Ireland.** *Lower Castle Yard, Dublin, Ireland.*	
E—15	**Technical Index, The.** *M. J. Fitz-patrick,* *88 Chancery Lane,* *London, W.C.*	*Monthly.* *Ordinary Edition Per yr. $2.50* *Card Indexing Edi. " $4.50*
E—16	**Transactions of the Canadian Institute.** *58 Richmond Street, Toronto, Canada.*	
E—17	**Transactions of the Canadian Society of Civil Engineers.** *Montreal, Canada.*	
E—18	**Transactions of the Institution of Naval Architects.** *5 Adelphi Terrace, London, W.C.*	

E—19	**United Service Gazette.** *43, 44 Temple Chambers.* *London, E.C.*	*Weekly* *Per year £1 10s 6d*
E—20	**United Service Magazine.** *23 Cockspur Street, Charing Cross,* *London, S. W.*	*Monthly.* *Per year £1 1s*

FRANCE.

F— 0	**France Militaire, La** *10 Rue Danton, Paris.*	*Daily* *Per year 32 fr*
F— 1	**Genie Civil, Le** *6 Rue de la Chaussee d'Antin, Paris.*	*Weekly* *Per year 45 fr*
F— 1a	**Liste Navale Francaise.** *Quai Cronstadt, au coin de la Rue Neuve,* *Toulon, France.*	*Quarterly* *Per year 9 fr*
F—1b	**Journal des Sciences Militaires.** *30 Rue et Passage Dauphine (VI^{e}),* *Paris, France.*	*Semi-monthly* *Per Year 40 fr*
F— 2	**Memoires et Travaux de la Societe des Ingenieurs Civils.** *19 Rue Blanche,* *Paris.*	*Monthly* *Per year 36 fr*
F— 3	**Memorial des Poudres et Salpetres.** *55 Quai des Grands-Augustins, Paris.*	*Semi-annually* *Per year 13 fr*
F—3d	**Mois Scientifique et Industriel, Le.** *8, Rue Nouvelle, Paris, France.*	*Monthly* *Per year, $5.00*
F— 4	**Monde Militaire, Le** *6 Rue de la Chaise, Paris.*	*Fortnightly* *Per year 7 fr 50*
F— 5	**Revue d'Artillerie.** *5 Rue des Beaux-Arts, Paris.*	*Monthly.* *Per year 22 fr*
F— 6	**Revue de Cavalerie.** *5 Rue des Beaux-Arts, Paris.*	*Monthly* *Per year 33 fr*
F—6a	**Revue de L' Aviation.** *8, Rue de la Grange Bateliere.* *Paris, France.*	*Monthly* *Per year 8 fr*
F— 8	**Revue du Genie Militaire.** *5 Rue des Beaux-Arts, Paris.*	*Monthly* *Per year 27 fr*
F— 9	**Revue d'Infanterie.** *10 Rue Danton, Paris.*	*Monthly* *Per year 25 fr*
F—10	**Revue Maritime.** *30 Rue et Passage Dauphine, Paris.*	*Monthly* *Per year 46 fr*
F—11	**Revue Militaire des Armees Etrangeres.** *R. Chapelot et Cie.,* *30 Rue et Passage Dauphine, Paris.*	*Monthly* *Per year 15fr*
F—11a	**Technique Aeronautique, La** *32 Rue Madame, Paris.*	*Monthly* *Per year 25 fr*
F—12	**Le Yacht—Journal de la Marine.** *55 Rue de Chateaudun, Paris.*	*Weekly* *Per year 32 fr*

GERMANY.

G— 1	**Artilleristische Monatshefte.** *Mohrenstr. 19, Berlin, W. 8,*	*Monthly* *Per year 24 M*

G— 2	**Der Ingenieur.** *Cardel & Renne, Berlin W 15,* *Lietzenburger Strasse 2.*	*Semi-monthly* *Per year 14 M*
G— 3	**Eisen-Zeitung.** *Verlag von Otto Elsner, Berlin S. 42.*	*Weekly* *Per year 12 M*
G— 4	**Kriegstechnische Zeitschrift.** *Koch Strasse, 68-71, Berlin, S. W.*	*Ten numbers a year* *Per year 10 M*
G— 5	**Marine Rundschau.** *Koch Strasse, 68-71, Berlin, S. W.*	*Monthly* *Per year 8 M*
G— 6	**Militaer Wochenblatt.** **Beiheft.** *Koch Strasse, 68, Berlin, S. W. 12.*	*Semi-weekly* *Per year 20 M*
G— 7	**Schiffbau.** *Zimmerstr., 8, Berlin, S. W., 68.*	*Semi-monthly* *Per year 20 M*
G— 8	**Stahl und Eisen.** *Jacobistrasse 5, Düsseldorf.*	*Weekly* *Per year 24 M*
G— 9	**Ueberall.** *Verlag: Boll und Pickardt,* *Georgenstrasse 23, Berlin, N. W.*	*Monthly* *Per year 12 M*
G—10	**Zeitschrift fuer das Gesamte Schiess- und Sprengstoffwesen.** *J. F. Lehmann's Verlag, Munich.*	*Fortnightly* *Per year 26 M*

ITALY.

I— 0	**Bibliofilo Militar.** *Via Urbana Num. 4, Rome.*	*Monthly* *Per year 25 L*
I— 1	**L'Ingegneria Ferroviaria.** *Via del Leoncino n. 32, Rome.*	*Fortnightly* *Per year 20 L*
I— 1a	**Lista Navale Italiana.** *Rome, Italy.*	*Quarterly* *Per year 15 L*
I— 2	**Rivista di Artiglieria e Genio.** *Tipografia Enrico Voghera,* *Via Astalli 15, Rome.*	*Monthly* *Per year 20 L*
I— 3	**Rivista Marittima.** *Economo del Ministero della Marina,* *Rome.*	*Monthly* *Per year 25 L*
I— 4	**Bollettino Della Societa Aeronautica Italiana.** *Via della Muratte, 70, Rome.*	*Monthly* *Per year, 18 L.*

PORTUGAL.

P— 1	**Annaes do Club Militar Naval.** *43 Rua do Carmo, Lisbon, Portugal.*	*Monthly* *Per year $3.85*
P— 2	**Revista de Artilharia.** *Rua do Carmo, 43, 2º, Lisbon.*	*Monthly* *Per year 12 fr*
P— 3	**Revista de Engenheria Militar.** *27 Rua Nova da Almada, Lisbon.*	*Monthly* *Per year 16 fr*
P— 4	**Revista Militar.** *Largo da Annunciada, 9, Lisbon.*	*Monthly* *Per year 2 2400 reis*

RUSSIA.

R— 3	**Imperial Nicholai War Academy Recorder, The.** *St. Petersburg, Russia.*	*Monthly* *Per year 6 rubles*

SCANDINAVIA AND DENMARK.

Sc— 1	**Artilleri-Tidsskrift.**	*Bi-monthly*
	Artillerigarden, Stockholm, Sweden.	*Per year, U. S., $1.75*
Sc— 2	**Militaert Tidsskrift.**	*Semi-monthly*
	Copenhagen, Denmark.	*Per year, U. S., $2.50*
Sc— 3	**Norsk Artilleri-Tidsskrift.**	*Bi-monthly*
	Christiania, Norway.	*Per year, $1.50*
Sc— 4	**Norsk Militaert Tidsskrift.**	*Monthly*
	Christiania, Norway.	*Per year, U. S., $2.50*

SPAIN.

Sp— 1	**Memorial de Artilleria.**	*Monthly*
	Museo de Artilleria, Madrid.	*Per year, $3.50*
Sp— 2	**Revista Cientifico-Militar.**	*Semi-monthly*
	Paseo de San Juan, 201, Barcelona.	*Per year 40 fr*
Sp— 3	**Revista General de Marina.**	*Monthly*
	Ministerio de Marina, Madrid.	*Per year $4.45*

SWITZERLAND & BELGIUM.

S— 1	**Allgemeine Schweizerische Militaer-Zeitung.**	*Weekly*
	Basel, Switzerland.	*Per year 8 fr*
S— 2	**Revue Militaire Suisse.**	*Monthly*
	23 Escaliers-du-Marche, Lausanne, *Switzerland.*	*Per year 12 fr 50*
S— 3	**Schweizerische Monatschrift fuer Offiziere Aller Waffen.**	
	Frauenfeld, *Switzerland.*	*Monthly* *Per year 5 fr*
S— 4	**Schweizerische Zeitschrift fuer Artillerie und Genie.**	*Monthly*
	Frauenfeld, Switzerland.	*Per year 7 fr*
S— 5	**La Belgique Militaire.**	*Weekly*
	Rue Albert de Latour 50, *Schaerbeck, Brussels.*	*Per year 12 fr 50*
S— 6	**Revue de l'Armee Belge.**	*Bi-monthly*
	24 Rue des Guillemins, Liege, Belgium.	*Per year 13 fr*

UNITED STATES.

U.S.— 0	**Aeronautics.**	*Monthly*
	1777 Broadway, New York City.	*Per year $3.00*
U.S.—0a	**Air-Scout, The.**	*Monthly*
	U. S. Aeronautical Reserve, *53 Fifth Avenue, New York City.*	*Per year $1.00*
U.S.—0aL	**American Historical Review.**	*Quarterly*
	The Macmillan Company, *41 N. Queen Street, Lancaster, Pa., or* *66 Fifth Avenue, New York City.*	*Per yer $4.00*
U.S.— 1	**American Journal of Mathematics.**	*Quarterly*
	Johns Hopkins University, *Baltimore, Md.*	*Per year $5.00*
U.S.— 2	**Arms and The Man.**	*Weekly*
	1502 H Street, N.W., Washington, D. C.	*Per year $3.00*

U.S.— 3	**Army and Navy Journal.** *20 Vesey Street, New York.*	*Weekly* *Per year $6.00*
U.S.— 4	**Army and Navy Register.** *Washington, D.C.*	*Weekly* *Per year $3.00*
U.S.—4a	**Bulletin of the American Geographical Society.** *15 West 81st Street, New York City.*	*Monthly* *Per year $5.00*
U.S.— 5	**Bulletin of the American Institute of Mining Engineers.** *29 West 39th Street, New York.*	*Bi-Monthy*
U.S.— 6	**Bulletin of the American Mathematical Society.** *501 West 116th Street, New York.*	*Ten numbers per year* *Per year $5.00*
U.S.— 6a	**Bulletin of the Bureau of Standards.** *Department of Commerce and Labor, Washington, D.C.*	
U.S.—6aL	**Bulletin of the International Bureau of the American Republics.** *Washington, D. C.*	*Monthly* *Per year $2.00*
U.S.— 7	**Bulletin of the University of Illinois.** *Urbana, Illinois.*	
U S — 7a	**Bulletin of the University of Wisconsin.** *Madison, Wisconsin.*	*Bi-monthly* *25c per copy*
U.S.— 8	**Cassier's Magazine.** *3 West 29th Street, New York.*	*Monthly* *Per year $3.00*
U.S.—8b	**Compressed Air.** *Compressed Air Magazine Co.* *Easton, Pa.*	*Monthly* *Per year $1.50*
U.S.—8c	**Confederate Veteran.** *Nashville, Tenn.*	*Monthly* *Per year $1.00*
U.S.— 8a	**Craftsman, The.** *29 W. 34th Street, N. Y.*	*Monthly* *Per year $3.00*
U.S.— 9	**Electric Journal, The.** *422-4 Sixth Ave., Pittsburg, Pa.*	*Monthly* *Per year $1.50*
U.S.—10	**Electrical Review and Western Electrician.** *Marquette Building, Chicago.*	*Weekly* *Per year $3.00*
U.S.—11	**Electrical World.** *239 West 39th Street, New York.*	*Weekly* *Per year $3.00*
U.S.—13	**Engineering Magazine, The.** *140-142 Nassau Street, New York.*	*Monthly* *Per year $3.00*
U.S.—15	**Engineering News.** *220 Broadway, New York.*	*Weekly* *Per year $5.00*
U.S.—16	**Engineering Record.** *239 West 39th Street, New York.*	*Weekly* *Per year $3.00*
U.S.—16d	**Field Artillery Journal, The.** *U. S. Field Artillery Association,* *1744 G Street, N. W., Washington, D.C.*	*Quarterly* *Per year, $4.00*
U.S.—16a	**General Electric Review.** *General Electric Company,* *Schenectady, New York.*	*Monthly.* *Per year $2.00*
U.S.—16b	**Infantry Journal.** *U. S. Infantry Association,* *Colorado Building, Washington, D. C.*	*Bi-Monthly* *Per year, $3.00*
U.S.—19L	**Journal American History.** *617-619 Chapel St., New Haven, Conn.*	*Quarterly* *Per year $3.00*

U.S.—20 **Journal American Society of Naval Engineers.** *Navy Department, Washington, D.C.*	*Quarterly* *Per year $5.00*
U.S.—21 **Journal of the Association of Engineering Societies.** *31 Milk Street,* *Boston, Mass.*	*Monthly* *Per year $3.00*
U.S.—22 **Journal of the Franklin Institute.** *15 South Seventh Street, Philadelphia, Pa.*	*Monthly* *Per year $5.00*
U.S.—22c **Journal of Industrial and Engineering Chemistry.** *The American Chemical Society,* *Easton, Pa.*	*Monthly* *Per year $6.00*
U.S.—23 **Journal of the Military Service Institution.** *Governors Island, New York.*	*Bi-monthly* *Per year $3.00*
U.S.—23a **Journal of the U. S. Artillery.** *Fort Monroe, Virginia.*	*Bi-monthly* *Per year $2.50*
U.S.—24 **Journal of the U.S. Cavalry Association.** *Fort Leavenworth, Kansas.*	*Bi-monthly* *Per year $2.00*
U.S.—26 **Journal of the Western Society of Engineers.** *1734 Monadnock Block, Chicago, Illinois.*	*Bi-monthly* *Per year $3.00*
U.S.—26a **Kansas University Science Bulletin.** *Lawrence, Kansas.*	
U.S.—27 **Machinery.** *49-55 Lafayette Street, New York.*	*Monthly* *Per year $2.50*
U.S.—28 **Marine Review.** *Cleveland, Ohio.*	*Monthly* *Per year $1.00*
U. S.—28a **Metal Industry, The.** *99 John Street, New York.*	*Monthly* *Per year $1.00*
U.S.—29 **Military Surgeon, The.** *Union Trust Building, Washington, D. C.*	*Monthly* *Per year $3.50*
U.S.—30 **Mines and Minerals.** *Scranton, Penn.*	*Monthly* *Per year $2.00*
U.S.—30d **National Defense.** *136-140 East Gay St., Columbus, Ohio.*	*Monthly* *Per year, 50c*
U.S.—30L **National Geographic Magazine, The.** *Hubbard Memorial Hall,* *Washington, D. C.*	*Monthly* *Per year, $2.50*
U.S.—30a **National Guard Magazine, The.** *Columbus Savings and Trust Building,* *Columbus, Ohio.*	*Monthly* *Per year $1.00*
U.S.—31 **Navy, The.** *732 13th Street N. W., Washington, D.C.*	*Monthly* *Per year $1.00*
U.S.—31d **Official Gazette of the United States Patent Office, The.** *Supt. of Documents, Gov. Printing Office,* *Washington, D. C.*	*Weekly* *Per year $5.00*
U.S.—31a **Pennsylvania Magazine of History and Biography.** *Philadelphia, Pa.*	*Quarterly* *Per year $3.00*
U.S.—32 **Physical Review.** *66 Fifth Avenue, New York.*	*10 numbers per year* *Per year $5.00*
U.S.—32a **Polytechnic, The.** *Troy, N. Y.*	*10 numbers per year* *Per year $1.00*
U.S.—33 **Popular Mechanics.** *225 Washington Street, Chicago, Ill.*	*Monthly* *Per year $1.50*

U.S.—34L Proceedings American Institute of Electrical Engineers.
33 West 39th Street, *Monthly*
New York. *Per year $5.00*

U.S.—35 Proceedings of the American Philosophical Society.
104 South Fifth Street, Philadelphia, Pa.

U.S.—36 Proceedings of the American Society of Civil Engineers.
220 West 57th Street, New York. *Monthly*

U.S.—37 Proceedings American Society of Mechanical Engineers.
33 West 39th Street, New York. *Monthly*

U.S.—38 Proceedings of the Engineers' Club of Philadelphia.
1317 Spruce Street, *Quarterly*
Philadelphia, Pa. *Per Vol. $2.00*

U.S.—39 Proceedings of Engineers Society of Western Pennsylvania.
803 Fulton Bldg., *Monthly*
Pittsburg, Pa. *Per year $5.00*

U.S.—40 Proceedings of the U. S. Naval Institute. *Quarterly*
Annapolis, Md. *Per year $3.00*

U.S.—40a Professional Memoirs. *Quarterly*
Washington Barracks, D. C. *Per year $3.00*

U.S.—40b Reactions. *Quarterly*
Goldschmidt Thermit Company, *Free*
90 West Street, New York City.

U.S.—41 Review of Reviews. *Monthly*
13 Astor Place, New York. *Per year $3.00*

U.S.—41c Science Conspectus.
Massachusetts Institute of Technology, Boston, Mass.

U.S.—42 Scientific American, The. *Weekly*
361 Broadway, New York. *Per year $3.00*

U.S.—43L Scientific American Supplement. *Weekly*
361 Broadway, New York. *Per year $5.00*

U.S.—44 Seventh Regiment Gazette, The. *Monthly*
30 West 33rd Street, New York. *Per year $1.50*

U.S.—44b Southern Electrician. *Monthly*
Cotton Publishing Co., Atlanta, Ga. *Per year, 50c*

U.S.—44a Stevens Institute Indicator. *Quarterly*
Hoboken, N. J. *Per year $1.50*

U.S.—44d Technical World Magazine. *Monthly*
1 Madison Avenue, New York, N. Y. *Per year, $1.50*

U.S.—45a Telephone Engineer. *Monthly*
Monadnock Building, Chicago, Ill. *$2.00 per year*

U.S.—46 Transactions of the American Society of Civil Engineers.
220 West 57th Street, New York.

U.S.—47 Transactions of the Society of Naval Architects and Marine Engineers.
29 West 39th Street, New York.

U.S.—47L Virginia Magazine of History and Biography, The.
Virginia Historical Society, *Quarterly*
Richmond, Va. *Per year, $5.00*

MISCELLANEOUS.

M— 1 Boletin del Centro Naval. *Monthly*
Florida 659, Buenos Aires, Argentine. *Per year* $\$^{m}/_{n}$ *11.90*

M— 1b Boletin de Ingenieros. *Monthly*
War Dept., Mexico City, Mexico.

M—1a Boletin de Minas. *Monthly*
Lima, Peru.

M— 2 Boletin del Ministerio de Guerra y Marina. *Fortnightly*
Apartado de Correo 37 Lima, Peru.

M—2c Boletin Militar (Venezuela). *Monthly*
Ministerio de Guerra y Marina,
Caracas, Venezuela.

M—2b Memorial del Estado Mayor del Ejercito de Chile.
Falleres del Estado Mayor-Jeneral. *Bimonthly*
Santiago de Chile.

M—2d O Tiro.
Rio de Janeiro, Brazil.

M—2a Proceedings and Year Book of the Association for Military Science.
34 Maria Street, The Hague, Holland.

M— 3 Revista del Ejercito y Marina. *Monthly*
Departamento de Estado Mayor,
City of Mexico.

M— 4 Revista de Marina. *Monthly*
Casilla del Correo 976, Valparaiso, Chili. *Per year $10.00*

M— 5 Revista Maritima Brazileira. *Monthly*
Rua D. Manoel n. 3, *Per year $6.00*
Rio de Janeiro, Brazil.

M— 6 Revista Militar. *Monthly*
Paseo Colon, Buenos Aires, Argentine. *Per year $9m/n*

M— 7 Revista Militar. *Monthly*
Colegio Militar, Avenida 12 de Diciembre, *Per year $3.00*
La Paz, Bolivia.

M— 8 Revista Militar. *Monthly*
Rio de Janeiro, Brazil.

Synopsis of Index

As far as possible the entries of the Index are grouped according to the following synopsis:—

Artillery Material,
    coast,
    field,
    explosives,
    projectiles,
    general (including armor, etc.),
    range finders,
    sights, etc.,
Automobiles,
  Aerostation,
Ballistics,
    exterior,
    interior,
    penetration,
Range Finding and Pointing,
    position finding,
Cavalry,
    equipment,
    mounts,
Chemistry,
  Photography,
Drill Regulations,
  Maneuvers,
  Practice,
    artillery, coast,
    artillery, field,
    cavalry, (practical training),
    infantry, (practical training),
    general,
    naval,
Electricity,
    communications,
    general,
    light,
    power,
    storage batteries,
Boilers,
  Engines,
    gas,
    steam,
    general,
Mechanism, Mines, Torpedoes, etc.

Index

Cumulated—Vol. 35, January to June, 1911.

[Periodicals from November 16, 1910 to May 15, 1911.]

ARTILLERY MATERIAL

Coast:

Some comments on erosion and ballistics—US-40, Dec., 10.
Saint-Chamond 24 cm. coast howitzer—S-5, Nov. 27, 10.
The life and power of heavy ordnance—E-5, Dec. 2, 10.
Initial velocity as affected by erosion—US-23a, Nov.-Dec., 10.
Gun erosion—US-23a, Nov.-Dec., 10; I-3, Jan., 11.
The bomb cannon. A novel type of heavy ordnance—US-42, Nov. 5, 10.
The testing of a big gun—US-43L, Nov. 5, 10.
Artillery in 1909 according to Lobell's Jahresberichte—I-2, Nov., 1910.
Tactical-technical considerations on the armament and supply of seacoast batteries—I-2, Nov., 1910.
Guns or howitzers—E-7, Feb., 1911.
The type of weapon for coast armaments—E-7, Feb., 1911.
The type of gun for coast defense—E-7, Feb., 1911.
The armament of maritime fortifications—M-2, Nov. 15, 10.
Artillery calibration—M-4, Oct., 10.
Theory of artillery fire, with carriages not provided with hydraulic recoil cylinders—I-2, December, 10.
The erosion of gun tubes and heat phenomena in the bore of a gun—E-4, March 24, 31 and April 7, 14, 21, 11.
Odd shaped carriages, without buffers and recoils—I-2, January, 11.
The causes of bore erosion and its connection with the use of nitro powders —A-1, No. 1, 11.
Wind allowance in rifle shooting—E-1, April, 11.
Vicker's ordnance at the Japan-British Exhibition—US-23a, March-April, 11.
The 15-inch gun from an engineer's point of view—E-4, May, 5 11.
Erosion and ballistics: A rejoinder—US-23a, March-April, 11; US-40, Dec., 10.
The stiffness of guns—US-23a, January-February, 11; E-5, Dec. 30, 10.
Cause of gun accidents—US-23a, March-April, 11.

Field:

Field guns *versus* howitzers for field artillery—E-7, Nov., 10.
Krupp howitzers—S-2, Dec., 10.
Krupp 12 cm. field howitzers—I-2, Oct., 10.
The use of explosives in aerial warfare—E-11, Nov. 25, 10.
Method of avoiding some inconveniences in artillery with differential recoil—I-2, Sept., 10.
Question of heavier guns for field artillery—US-23, Jan.-Feb., 11.

- Engineering,
  - general civil, canal, river and harbor, materials, and processes (as may be of application in military and river and harbor work).
  - millitary,
  - fortifications.
- Metallurgy (manufacture of ordnance materials).
- Military Geography.
- History and Biography.
  - battles, campaigns,
  - general military,
  - general naval,
  - recent.
- Military Schools.
- Organization and Administration,
  - coast defense,
  - field artillery,
  - army, (by countries, England, Germany, Austria, France, Italy, Russia, Japan, Minor States, United States),
  - general military,
  - technical troops,
  - transport and supply,
  - medical,
  - naval.
- Reconnaissance and sketching.
- Signalling.
- Small Arms,
  - Equipment, (Infantry).
- Strategy,
  - Tactics,
    - artillery, coast,
    - artillery, field,
    - cavalry,
    - infantry,
    - general,
    - naval.
- Submarines,
  - Torpedo Boats,
    - Warships, (by countries, England, Germany, Austria, France, Italy Russia, Japan, Minor States, United States.)
    - general naval matters as regards construction and armament.
- Miscellaneous.

The modern German field artillery—S-4, Dec., 10.
British and French Q. F. artillery—E-7, Dec., 10.
New French 6.5 c.m. mountain gun—S-1, Dec. 17, 10.
Artillery in 1909 according to Lobell's Jahresberichte—I-2, Nov., 10.
German field artillery—S-4, Nov., 10.
The new Russian mountain gun—G-4, Sept., 10.
Guns and projectiles for the attack of airships—A-1, Nov., 10.
The Italian artillery—S-4, Oct., 10.
Vicker's automatic rifle caliber gun—E-5, April 28, 11.
The care and training of artillery remounts—US-16d, January-March, 11.
A universal gun for field artillery—G-4, No. 2, 11.
Destruction of airships—Sc-3, No. 6, 10.
Howitzers and cannon in field warfare—G-1, No. 49, 11.
The new French mountain gun (a gun equipped with differential recoil)—G-4, No. 1, 11.
Study of a system of closing the breech and of a cartridge without a metallic case for rapid fire cannon—I-2, December, 10.
Krupp balloon artillery—US-15, April 13, 11.
Vicker's ordnance at the Japan-British Exhibition—US-23a, March-April, 11.
The coming field piece—G-6, April 11, 11.
The Swiss field howitzer—G-4, No. 4, 11.

Explosives:

English experiments with flameless powder—A-3, Dec., 10.
Explosives—A-4, Dec. 16 and 30, 10.
French powders—G-10, Dec. 15, 10.
Cordite. Its chemistry and manufacture—US-40, Dec., 10.
The use of chlorates in commercial explosives—US-15, Jan. 15, 11.
Deterioration of powders and explosives—G-10, Dec., 15, 10.
The stability of smokeless powder—US-40, Dec., 10.
The explosion of the Chilian powder magazines of Batuco—US-23a, Nov.-Dec., 10.
Abel on detonation (1869)—E-1, Dec., 10.
The *Puritan* test of high explosives—US-23a, Nov.-Dec., 10.
Modern powders. Theoretic study—M-3, Sept., 10.
Trinitrololuol as the military explosive of the age—M-3, Sept., 10.
The Royal powder factory at Wetteren (Belgium)—S-5, Nov. 6, 10.
Spanish experiments with projectiles and powder—G-10, Nov. 1, 10.
Precautions in the use of explosives—US-43L, March 11, 11.
French service powder—G-10, Dec. 1, 10.
Stability tests of powder—G-10, Nov. 15, 10.
Centrifugal machines for powder works—G-10, Nov. 1, 15, Dec. 1, 15, 10.
Modern explosives. Lectures given in the School of Military Equitation—Sp-1, Sept., 10.
Naval ordnance and smokeless powder—E-5, Jan. 27, 11.
The discovery of fulminate of mercury (1800)—E-1, Jan., 11.
Smokeless powders—P-2, Jan., 11.
Report of the work of the explosions commission in 1908 and 1909 (France)—F-3, parts 3 and 4, vol. XV.
Reply to Maxim's charges as to smokeless powders in the United States service—US-4, Dec. 31, 10.
Our smokeless cannon powder the best—US-42, Jan. 21, 11.

Protective apparatus against lightning for manufactories of explosives—G-10, May 1, 11.
On temperature of explosives—A-2, No. 2, 11.
Inspection and testing of explosives—Sc-3, No. 6, 10.
The causes of bore erosion and its connection with the use of nitro powder—A-1, No. 1, 11.
Spectroscopic proof that traces of quicksilver are contained in nitrocellulose—G-10, Jan. 15, Feb. 15, 11.
Modern explosives—M-1, Jan., 11.
Modern apparatus for the study of explosives—M-1, Jan., 11.
Noble's patents. For the manufacture and detonation of nitroglycerine (1864), dynamite (1867), straight dynamite (1869), blasting gelatine and gelignite (1875), and ballistite (1888)—E-1, May, 11.

Projectiles:

Universal projectile—G-4, Dec,, 10.
Capped projectiles—G-1, Dec., 10.
Shape of projectiles and air resistance—E-1, Jan., 11.
The Ehrhardt "Brisant shrapnel" and the Krupp shrapnel—S-2, Oct. and Nov., 10.
Another voice for the Krupp shrapnel as compared with the Ehrhardt high explosive shrapnel—S-2, Feb., 11.
Guns and projectiles for the attack of airships—A-1, Nov., 10.
Spanish experiments with projectiles and powder—G-10, Nov. 1, 10.
Progress towards a universal projectile—G-10, Nov. 1, 10.
Experiments with universal projectiles—G-1, Oct., 10.
On the road to the universal shell—G-10, Mar. 1, 15, 11.
New studies concerning the shrapnel—G-1, No. 49, 11.
Projectiles for use against aerial machines—I-2, Dec., 10.

General:

The coast defense of Holland—F-0, Jan. 11, 11.
The progress of war material in 1910—E-4, Jan. 6, 11.
Coast artillery searchlights—A-2, Dec., 10.
Field searchlights—US-40a, Jan.-Mar., 11.
Artillery equipment, 1909—US-23a, Nov.-Dec., 10.
The present state of the machine-gun question—the machine gun, or the automatic rifle—S-6, July-August, 10.
The heavy, or the light, machine gun—S-6, July-August, 10.
Armor in fortification plans—G-4, Dec., 10.
Hand grenades and aerial torpedoes—A-3, Dec., 10.
The hand grenade—US-3, Dec. 3, 10; S-5, Dec. 18, 10; G-4, Sept., 10; M-2, Jan. 15, 11.
The new armor—US-42, May 13, 11.
Description of a deflection correction device—US-23a, Mar.-April, 11.
Work of the Artillery Board (Spain).—Report on siege guns, powders and explosives, machine guns—Sp-1, April, 11.
Hand *versus* rifle grenades—A-3, No. 2, 11.
Nocturnal warfare. An automobile-mounted searchlight for the French army—US-42, April 8, 11.
The modern machine gun—US-23, March-April, 11.
Machine guns—G-6, Nov. 8 and 10, 10.
Electrical projectors—M-2, Aug. 31, 10.

Report of the 1st Section of the Central Firing School of the Army on the best model of field glasses for artillery officers—Sp-1, Dec., 10.
Maxim machine guns—M-2, Aug. 31, 10.
Range Finders:
The Stroobant telemeter. Its complete theory—S-6, July-August, 10.
For a range indicator for seacoast cannon—I-2, Nov., 10
General description of the depression position plotter—US-40a, April-June, 11.
Sights, etc.:
Some tests on the accuracy of telescopic sighting—A-2, No. 1, 11.

AUTOMOBILES, AEROSTATION

Automobiles
Automobile cylinder lubricating oils—US-42, Jan. 14, 11.
Jarman's system of electric traction by storage batteries—US-43L, Jan. 14, 11.
Auto-trucks for the army—US-23, March-April, 1 .
Aerostation:
Aeroplanes in Paris—US-43L, Nov. 19 and 26, 10.
Wireless communications from airships. The apparatus used in the dirigible *America*—US-8, Jan., 11.
Experiments with aeroplane wireless—US-0, Jan., 11.
The second exposition of aerial and automobile navigation—F-11a, Dec. 1, 10.
The aeroplane and war—F-1b, Dec. 1, 10.
New aeroplane duration and distance records—US-42, Dec. 31, 10.
How altitude records are made—US-42, Dec. 24, 10.
The general theory of propulsive helices—F-11a, Dec. 1, 10.
Aeroplanes and airship engines—US-27, Jan., 11.
The use of aeroplanes in future wars—G-6, Dec. 31, 10.
Attack of airships—G-6, Dec. 15, 10.
Progress in airships—A-3, Dec., 10.
Use of aeroplanes in naval warfare—A-1, Jan., 11.
Progress in aviation in 1910—US-43L, Jan. 7, 11.
The N.E.C. two-cycle aeroplane engine—E-11, Jan. 6, 11.
Progress in aeronautics—E-20, Dec., 10, and Jan., April, May, 11; E-19, Mar., 11.
Dirigibles and aeroplanes—A-3, Nov., 10.
Parachutes for aeroplanes—G-4, Dec., 10.
Airships—G-4, Dec., 10.
Use of dirigibles and aeroplanes in war and the fight against them—S-2, Dec., 10.
The work of the English aeronautic commission—F-10, Dec., 10.
Aerial navigation and naval warfare—F-10, Dec., 10.
Aviation in the navy (France)—F-10, Dec., 10.
The practice of aviation—F-11a, Dec. 15, 10.
The aeroplane in the navy—F-12, Dec. 24, 10.
Six aviation engines—US-43L, Dec. 17, 10.
Launching an aeroplane from a warship—US-42, Nov. 26, 10.
Study of an aeroplane with variable speed—F-1, Dec. 24, 10.
Determining the height of aeroplanes—US-43L, Dec. 24, 10.
Flying machines, living and lifeless—US-42, Dec. 10, 10.
The first marine aeroplane—US-42, Dec. 17, 10.
Balloon signals—US-43L, Jan. 14, 11.
Automatic stabilizing system of the Wright Brothers—US-43L, Jan. 14, 11.

Practice and theory of aviation. The leading aeroplanes—US-43L, Oct. 29, Nov. 5, 19, 26, and Dec. 3, 10.
The Willows dirigible airship—US-43L, Dec. 3, 10.
The Paris aeronautical exhibition. The most recent aeroplanes and motors—US-8, Jan., 11.
Aeronautics—E-5, Jan. 13, 11.
First principles of aviation—US-0a, Jan., 11.
Present status of military aeronautics—US-0a, Jan., 11.
The gentle art of aviation—US-0a, Jan., 11.
New military aeroplanes in France—I-2, Oct., 10.
The fallacy of the new screw propeller—US-0, Jan., 11.
Notes on the aeroplane propeller—US-0, Jan., 11.
The use of explosives in aerial warfare—E-11, Nov. 25, 10.
The military uses of the aerostat—E-14, Dec., 10.
Bird-men of centuries past—US-0a, Dec., 10.
Ely's flight from the *Birmingham*—US-0a, Dec., 10.
Learning to fly—US-0a, Dec., 10.
The aeroplane engine for 1911—US-0, Dec., 10.
Aeronautics and war—US-0, Dec., 10, Jan., 11.
The jurisprudence of the air—E-7, Dec., 10.
Aerial map making—US-0a, Dec., 10.
Practical use of the wireless on aeroplanes—US-0a, Dec., 10.
Story of the United States Aeronautical Reserve—US-0a, Dec., 10.
New England's share in the history of aeronautics—US 0a, Dec., 10.
The unstable equilibrium of the balloon—US-8b, Dec., 10.
A discussion of the war ballon and similar craft—US-23a, Nov.-Dec., 10.
Some general considerations which govern the design of an aeroplane—US-23a, Nov.-Dec., 10.
Bursting of the dirigible "Erbsloeh"—F-11a, Sept. 15, 10.
The stability of the biplane—F-9a, Oct. 1, 10.
Aeronautics in the navy—F-12, Oct. 15, 10.
Calculations of the tension of the envelope of a dirigible—F-11a, Sept. 15, 10.
Features and development of the dirigible airship—Sc-2, Feb. 15 and Mar. 1, 1908.
The employment of aeroplanes and balloons for military operations—Sc-4, No. 11, 10.
Balloons at the French maneuvers, 1910—Sc-2, Nov. 15, 10.
Classification of the different modes of flight—F-11a, Oct. 1, 10.
Classification of aeroplanes—F-11a, Nov. 1, 10.
Discussion of the ideas of Captain Piumatti on the use of dirigibles and aeroplanes in naval warfare—F-11a, Nov. 1, 10.
M. Canovetti's experiments upon the resistance of the air—F-11a, Nov. 1, 10.
Military aviation—F-4, Jan., 10.
Observation of the wind before ascending—F-11a, Nov. 1, 10.
The German aerial fleet—F-4, July, 10.
Report upon the aerial cruiser (Boerner system)—S-5, Sept. 18, 10.
Cavalry and aviation—S-5, Oct. 30, 10.
The dirigible *Belgique*—S-5, Oct. 30, 10.
Military aeronautics in Belgium—S-5, Sept. 18, Nov. 13, 20, 10.
The wonderful balloon record of the *America II*—US-42, Nov. 5, 10.
The International Aviation Meet—US-42, Nov. 5, 12, 10.

The importance of aeroplanes from the military point of view—S-5, July 24, 10.
Naval aeronautics—P-1, July and August, 10.
The navy and aviation (France)—F-12, Sept. 10, 10.
Construction and handling of the new aeroplanes—M-1b, Dec., 10.
Aerial navigation—M-1b, Jan., 11.
News of dirigibles in France, Germany and Italy—I-3, Feb., 11.
New aerial ports in Austria, France and Germany—I-3, Feb., 11.
The longitudinal stability of aeroplanes—F-12, March 11, 11.
Some results of the Göttingen (aeronautical) tests—F-12, March 11, 11.
The stability of aeroplanes—F-9a, March 1, 11.
Recent aeronautic progress. A new German airship and the Voisin military biplane—US-42, March 11, 11.
Notes on the history of balloon photography—US-22, March, 11.
Estimating the coefficient of reduction—E-1, March 1, 11.
Aviation—S-2, Feb., 11.
Instruction of a cyclist company—S-2, Feb., 11.
Aviation accidents—F-11a, Feb. 15, 11.
Curtiss's experiments in rising from the water—US-42, March 4, 11.
The role of aviation in the navy—F-10, Jan., 11.
New things in aeronautics. Height recorder for balloonists. Curtiss's new flying boat—US-42, Feb. 25, 11.
The naval dirigible balloon shed—E-4, Feb. 17, 11.
The airship for the British navy—E-5, Feb. 17, 11.
Aviation and aeroplane motors—E-11, Feb. 24, 11.
Some recent French monoplanes. Details of several new machines—US-42, Feb. 18, 11.
Success of the Curtiss hydro-aeroplane—US-0, March, 11.
The Dunne automatic stability system—US-0, March, 11.
Discussion of aviation accidents—F-11a, Feb. 1, 11.
The resistance of rectangular planes struck obliquely by the wind—F-11a, Feb. 1, 11.
The equilibrium of aeroplanes—F-9a, Feb. 1, 11.
The new rigid dirigible of the English navy *N. I.*—US-42, March 4, 11.
Capt. Bellenger's flight from Paris to Pordeaux and Pau—US-42, March 4, 11.
The Bleriot "Bus." A record passenger-carrying trip of a new monoplane—US-42, March 4, 11.
Captive balloons, or kites—F-5, Jan., 11.
Development of aeroplanes—A-1, Nov., 10.
Value of aeroplanes at French maneuvers—S-1, Oct. 22, 10.
Military use of aeroplanes—Sp-2, Sept. 25, 10.
Aeroplane flies to warship—US-4, Feb. 4, 11.
An English opinion on the use of aeroplanes and dirigibles in the field—F-9, Jan. 15, 11.
War and the aeroplane—US-0a, Feb., 11.
A year of aviation—US-0a, Feb., 11.
What Germany has done in military aeronautics—US-0a, Feb., 11.
Present status of military aeronautics—US-0a, Feb., 11.
Three French military balloon sheds—US-15, Feb. 9, 11.
First flight of an American aeroplane from water. How an important problem in the naval aeroplane was solved—US-42, Feb. 11, 11.
A discussion of accidents in aviation—F-11a, Jan. 15, 11.

Recent progress in aeronautics—E-11, April 14, 11.
Stability of aeroplanes by gyroscopes—F-5, Mar., 11.
Photography of the wind—F-11a, Mar. 15, 11.
Determination of the height reached by an aeroplane—F-11a, Mar. 15, 11.
A note upon the resistance of the air as applied to aviation—F-6a, April 1, 11.
Discussions of aviation—F-8, Mar., 11.
Life-savers for aviators—US-42, Mar. 25, 11.
Christening the *Suchard*—US-42, Mar. 25, 11.
The stability and resistance of aircraft—E-4, Mar. 17, 11.
Relative merits of dirigibles and aeroplanes—US-23, Mar.-April, 11.
Aviation exploits at home and abroad. Foulois on the Mexican border: the flight to the Puy de Dome—US-42, April 1, 11.
Aeroplanes in 1911—E-7, Mar., 11.
Destruction of airships—Sc-3, No. 6, 10.
Aviation—S-2, March, 11.
Discussions of aviation—F-8, Feb., 11.
Military aviation in Switzerland. (With several views taken from aeroplanes.) —S-2, Mar., 11.
Aeroplane scouting on Mexico's border—US-0a, April, 11.
The influence of aviation on tactics—E-20, April, 11.
Projectiles for use against aerial machines—I-2, Dec., 10.
The shelling of dirigible balloons—A-2, No. 1, 11.
The aero and motor-boat exhibition at Olympia. Engines for aeroplanes—E-5, April 7, 11.

BALLISTICS

Exterior:
Photographing the flight of projectiles—US-42, Nov. 26, 10.
Resistance and "drift" of a bullet—E-14, Jan., 11.
Shape of projectiles and air resistance—E-1, Jan., 11.
The new English ballistic tables—E-1, Dec., 10.
Calculating height of trajectory—E-1, Feb., 11.
The researches of Eiffel upon the resistance of rectangles to oblique winds—F-9a, Jan. 1, 11.
A new formula for calculating drift—G-10, Mar. 1, 15, 11.
The formulæ of fire of Siacci and the "new formulæ"—I-2, Dec., 10.
Interior:
Initial velocity as affected by erosion—US-23a, Nov.-Dec., 10.
A modification of the formulæ for interior ballistics—I-2, Sept., 10.
New empirical formulæ for interior ballistics—I-3, Feb., 11.
Erosion and ballistics: A rejoinder—US-23a, Mar.-April, 11; US-40, Dec., 10.

RANGE FINDING AND POINTING

Pointing by an independent line of sight—I-3, Nov., 10.
Range corrections from observation of fire—US-23a, Jan.-Feb., 11.
Ranging and fire control—M-6, Jan., Feb., 11.

CAVALRY

Equipment:
The Chinese military horse—G-6, April 13, 11.
Cavalry equipments—US-24, May, 11.

The work of the Cavalry Equipment Board—US-24, May, 11.

Mounts:

Cavalry seats and saddles—US-4, May 6, 11.

The Fort Reno remount depot—US-24, May, 11.

PHOTOGRAPHY

Photographing the flight of projectiles—US-42, Nov. 26, 10.

Notes on the history of balloon photography—US-22, March, 11.

Photography for the engineer—US-15, April 6, 11.

DRILL REGULATIONS, MANEUVERS AND PRACTICE

Drill Regulations:

New French field artillery regulations—G-6, Jan. 5, 11.

A criticism of our cavalry drill regulations—US-24, Jan., 11.

The new regulations for German foot artillery—F-11, June, July, Aug., 09.

Swiss infantry drill regulations—S-2, Sept., 10.

The infantry regiment in foreign drill regulations—S-2, Oct., 10.

Drill regulations for Swiss infantry. The brigade—S-2, Jan., 11.

New regulations for field fortifications for officers of all arms—F-9, April 15, 11.

A criticism of our cavalry drill regulations—US-24, May, 11.

The new regulations of the French field artillery—G-4, No. 2, 11.

Maneuvers:

Some impressions of the army maneuvers—E-10a, Dec., 10.

The field firing at Atascadero—US-2, Dec. 1, 10.

French fleet maneuvers, 1910—A-1, Dec., 10.

The fleet maneuvers of the Netherlands, 1909-1910—G-5, Jan., 11.

The Atascadero maneuvers—US-2, Jan. 5, 12, 11.

The French maneuvers in Picardie, 1910—S-1, Dec. 24 and 31, 10.

The Imperial German Maneuvers of 1910—F-1b, Dec. 1, 10; F-11, Mar., 11.

Balloons at the French maneuvers, 1910—Sc-2, Nov. 15, 10.

Field fortification and its application to the maneuver—I-2, Sept., 10.

The English Grand Maneuvers in 1909—F-11, Dec., 09.

The Imperial German Maneuvers in 1909—F-11, Mar., April, May, 1910.

Maneuvers of American militia in 1909—F-11, Dec., 09.

Aeronautical information from the Picardie maneuvers—F-4, Oct. 1, 10.

Italian maneuvers of 1909—F-11, Jan., 10.

The new German cavalry maneuver rules—F-11, Aug., Sept., 09.

Imperial Austro-Hungarian Maneuvers in 1908—F-11, July, 09.

The Imperial German maneuvers in 1908—F-11, March, 09.

The Imperial Japanese Maneuvers in 1908—F-11, April, 09.

Maneuvers in the fortified position at Liege—S-5, Sept. 18, 10.

Aeronautics at the grand maneuvers in Picardie—S-5, Oct. 9, 10.

French maneuvers, 1910—G-4, Sept., 10.

German maneuvers, 1910—G-9, Nov., 10.

Value of aeroplanes at the French maneuvers—S-1, Oct. 22, 10.

The Japanese maneuvers af 1910—F-0, Jan. 28, 11.

The Autumn Swedish maneuvers of 1910—F-11, Jan., 11.

The Swiss maneuvers of 1910—F-11, Jan., 11.

The Imperial Japanese maneuvers of 1910—F-0, Jan. 23, 11.
The great maneuvers of 1910 (naval-France)—F-12, Jan. 14, 11.
Lessons learned at a maneuver camp—US-29, Jan., 11.
Italian naval exercises (maneuvers) 1910—A-1, No. 1, 11.
A retrospect of the maneuvers—E-7, April, 11.
Grand maneuvers of foreign armies 1910 (Germany, Bulgaria, England)—A-3, No. 1, 2, 11.
Winter maneuvers in Norway—S-1, April 15, 11.

Practice—Artillery, Coast:

Firing and detonating trials against modern fortifications—US-23a, Nov.-Dec., 10.
Analysis of plotted results of target practice—US-23a, Nov.-Dec., 10.
Coast artillery firing in England, France, Italy and Austria-Hungary—A-2, No. 3, 11.

Practice—Artillery, Field:

Field artillery training of the organized militia—US-2, Dec. 22, 10.
The fire of field artillery—S-6, July-August, 10.
Mountain artillery practice—S-4, Nov., 10.
Preparation for and conducting of field artillery fire—Sp-1, Feb., 11.
The camp of instruction for national guard field artillery officers at Fort Riley, Kansas, June, 1910—US-16d, Jan.-Mar., 11.
How can the efficiency of field batteries of the organized militia be increased—US-16d, Jan.-Mar., 11.
The shelling of dirigible balloons—A-2, No. 1, 11.
Concerning comparative bursting and sensibility tests with the existing explosives of Switzerland—S-4, No. 1, 11.
The instruction of a field battery—I-2, Dec., 10.

Practice—Cavalry:

A practical practice march—US-24, Jan., 11.
A scheme of instruction for a cavalry command—US-24, Jan., 11.
Field trianing *versus* target practice—US-24, May, 11.
Cavalry instruction—US-24, May, 11.
The cavalry divisional training (1910)—E-10a, Jan.-Mar., 11.
On the history of horsemanship—G-6, April 4, 11.

Practice—Infantry:

Musketry training in peace and the effect of morale on musketry in war—E-10a, Dec., 10.
Twenty years of physical training in Germany and in France—F-9, Dec. 15, 10.
Rifle and machine gun fire compared—Sp-2, Oct. 10, 10.
Forced marches and winter drills of Japanese infantry—F-4, Sept., 10.
The training of light infantry—E-19, March, 1911.
Rapid fire rifle practice—US-2, Jan. 26, 11.
Reflections on the training of the infantry officer—E-9, April, 11.
Instruction of a company in field service—F-1b, Mar. 15, April 1, 15, 11.
The making of a soldier—US-25, Mar., 11.
Changes in training and infantry formations owing to experience gained in recent campaigns—E-14a, Feb. 15, 11.
The infantry scout—E-20, May, 11.

Practice—General:

Military training of boys in Austria—A-3, Nov., 10.
German siege warfare instruction—F-11, March, 11.

Tactical instruction of line officers—US-25, Mar., 11.
The training of column commanders—G-1, No. 51, 11.
Training to shoot—S-1, Feb. 25, 11.
How to conduct a siege maneuver on paper—I-2, Jan., 11.
The training of the organized militia—US-23, May-June, 11.
Specialisation in training—E-9, April, 11.
Instruction in the duties of engineer troops for the officers of all arms of the Russian Army—G-6, May 2, 11.
The new technical instructions for the infantry and cavalry (Austria)—A-3, April, 11.
Information from the Army School of Musketry—method of firing with machine guns—A-3, April, 11.

Practice—Naval:

Gun layers tests and battle practice—US-23a, Nov.-Dec., 10.
Naval battle practice—M-5, Aug., 10.
The *Puritan* experiment—US-40, March, 11.
Naval gunnery in 1910 (British)—E-19, Feb. 16, 11.
Sinking a battleship at six miles. The *San Marcus* (*Texas*) under fire—US-42, April 1, 11.
Firing on the old battleship *Texas*—US-3, Mar. 25, 11.
Naval ordnance test—US-4, Mar. 25, 11.
The navy's target practice (U. S.)—US-4, April 15, 11.
The English fleet maneuver of 1910—A-1, No. 4, 11.
Target practice of the French squadron during 1910—A-1, No. 4, 11.
Artillery marksmanship of the French navy 1910—G-5, No. 3, 11.
Shooting in the British navy—US-23a, Mar.-April, 11.
Experiments with guns *versus* armor (The *Katahdin*)—US-23a, Mar.-April, 11.

ELECTRICITY

Communications:

Radiotelegrafy from dirigibles and aeroplanes—I-2, Jan., 11.
Ruhmer's system of multiplex telephony—US-45a, May, 11.
A study of telegraphic transmission—US-45a, May, 11.
Field artillery telephone model—US-16d, Jan.-Mar., 11.
The theory and practice of wireless detectors as at present used—E-3b, Jan. 6, 11.
Wireless telegraphy. (Suggestion of a new intensifier)—E-3b, Jan. 13, 11.
Important developments in long distance telephony—US-10, Jan. 7, 11.
A simple wireless telephone—US-11, Jan. 12, 11.
Wireless communications from airships. The apparatus used in the dirigible *America*—US-8, Jan., 11.
Wireless telegraphy and telephony—US-43L, Dec. 3, 10.
Wireless telegraphy and telephony. A review of ethereal signalling methods—US-43L, Nov. 26, 10.
A system of multiplex telephony. An important telephone invention—US-10, Jan. 14, 11; US-45a, Feb., 11.
Experiments with aeroplane wireless—US-0, Jan., 11.
Long distance and the transmitter—US-45a, Jan., 11.
A liquid microphone—US-45a, Jan., 11.
The singing-spark system of wireless telegraphy—US-11, Dec. 15, 10.

Modifying good and bad wires when locating a telephone-cable fault—US-10, Nov. 26, 10.
Electrolytic detector for wireless telegraph—US-11, Dec. 8, 10.
Telephone repeaters—US-10, Nov. 19, 10.
Submarine cables for long distance telephone circuits—E-3b, Dec. 16, 23, 10; Jan. 27, 11.
Researches on microphones and long distance telephony—E-3a, Dec. 30, 10.
Dubilier's new commercial wireless telephone—E-3a, Dec. 30, 10.
The metal lamp filament. Its manufacture—US-43L, Dec. 24, 10.
Telephone repeaters—US-45a, Dec., 10.
Wireless time signals—E-3a, Dec. 9, 10.
Submarine cable-laying and repairing—E-3a, Dec. 9, 16, 10
Practical use of the wireless on aeroplanes—US-0a, Dec., 10.
The new Anglo-French submarine telephone cables—E-11, Dec. 16, 10.
Composite artillery type telephones—US-23a, Nov.-Dec., 10.
Researches on the transmission and long-distance telephony—US-10, Dec. 24, 10.
Experimental apparatus for wireless telephony—E-3a, Oct. 7, 10.
Wireless in railway service—E-3a, Oct. 14, 10.
The energy relations of certain detectors used in wireless telegraphy—E-3a, Nov. 11, 10.
Properties of the most important detectors used in wireless telegraphy—E-3a, Oct. 14, 10.
Recent developments in telegraphy and telephony—US-43L, Oct. 29, Nov. 5, 10.
Wireless telegraphy dirigibles—M-1, Nov., 10.
Marconi and others *vs.* British Radio-Telegraph and Telephone Co. (Ltd.) —E-3a, Feb. 24, 11.
An alternator for direct production of electric waves for wireless telegraphy—E-3a, Feb. 17, 11.
The "singing spark" system of wireless telegraphy—E-3b, Feb. 17, 11.
Developments in wireless telegraphy—US-20, Feb., 11.
Long distance telephony in America—US-45a, March, 11.
Submarine cables for telephone work—US-45a, March, 11.
Recent progress in wireless telegraphy in France and abroad—F-1, Feb. 4, 11.
Ruhmer's recent work in wireless telegraphy. Some new methods of transmitting speech without wires—US-42, March 4, 11.
Telephone and signal stations—A-2, Nov., 10.
Some notes on telephony. Facts and principles underlying modern practice —US-43L, Feb. 4, 11.
Wireless telegraphy—US-32a, Feb., 11.
A study of telegraphic transmission—US-45a, Feb., 11.
Aviation—Wireless Telegraphy—Telephony. What effect will they have on a modern battlefield, and a suitable role and organization for their use—E-9, Jan., 11.
The automatic telephone (Strowger & Berliner)—F-1, Jan. 14, 11.
A system of multiplex telegraphy and telephony—US-42, Jan. 21, 11.
Long distance telephony—US-10, Jan. 28, 11.
Celerity of work on telegraph lines—I-2, Dec., 10.
Carbon granules for telephone transmitters—E-3a, Mar. 31, 11.
Researches on multiplex telephony—E-3a, Mar. 31, 11.

A study of telegraphic transmission—US-45a, April, 11.
Wireless telegraphy from aeroplanes—E-3a, Mar. 17, 11.
Concerning American wireless engineering—US-11, Mar. 23, 11.
The development of wireless telegraphy in the Signal Corps of the United States Army—US-10, April 22, 11.
An artillery command line telephone exchange—E-7, April, 11.
Recent developments in telegraphy and telephony—E-14, May, 11.
Practical aspects of printing telegraphy—E-3a, May 5, 11.
Wireless telegraph working in relation to interferences and perturbations—E-3a, April 7, 14, 11; E-3b, April 21, 11.

General:

Meters—E-3b, Jan. 13, 11.
The latest developments in the manufacture of high-tension cables—E-3a, Jan. 13, 11.
Electrical properties of compound wires—US-11, Jan. 12, 11.
The Cuntz electric cable—US-44a, Jan., 11.
A new method for the absolute measurement of electric quantity—US-6a, Nov., 10.
A chemical specification for rubber-covered wires and cables—US-11, Nov. 24, 10.
A new method of produciing high-tension electrical discharges—US-15, Oct. 13, 10.
Separation of oil from condenser water by electrolysis—E-3a, Dec. 30, 10.
The use of aluminum for electric conductors—F-1, Dec. 24, 10.
The dielectric strength of oil—E-3a, Jan. 6, 11.
Electric cables—E-3a, Jan. 6, 11.
Currie's work on magnetism—E-3a, Jan. 6, 11.
Government specifications for electrical apparatus—US-40a, Jan.-Mar., 11.
The magnetic properties of iron and its alloys in intense fields—E-3a, Dec. 9, 10.
Usual statement of laws of magnetic attraction may mislead—US-10, Dec. 10, 10.
The effect of temperature on the electric strength of porcelain insulators—US-10, Dec. 10, 10.
The electric properties of selenium—US-10, Dec. 10, 10; US-10, Mar. 4, 11.
The new insulator "Bakelite"—US-15, Dec. 29, 10.
Recent developments in exact alternating-current measurements—E-3a, Dec. 9, 16, 10.
Irregularities in the rotating field of the polyphase induction motor—E-3a, Dec. 9, 10.
Some points in connection with transformers—E-3b, Dec. 9, 10.
The all-electric idea—E-11, Nov. 25, 10.
A new method of measuring the strength of magnetic fields—E-3a, Nov. 25, 10.
Electricity and the Panama Canal—E-3b, Nov. 25, 10.
Winding dynamo-electric machines—US-9, Dec., 10.
Mechanical forces in magnetic fields—US-34L, Dec., 10.
Problems in the operation of transformers—US-34L, Dec., 10.
The temperature co-efficient of resistance of copper—US-34L, Dec., 10.
Commercial electrical testing—US-16a, Dec., 10.
Hysteresis loops and Lissajou's figures, and the energy wasted in a hysteresis loop—E-3a, Oct. 7, 10.

Electrical properties of compound wires—US-11, Dec. 22, 10.
Some observations on the action of the condenser in a Ruhmkorff induction coil—E-3a, Nov. 11, 10.
Electric cables—E-3a, Oct. 14, 10.
Limitations of the Weston cell as a standard of electromotive force—E-3a, Oct. 14, 10.
Boosters—E-4, March 10, 11; Mar. 17, 24, and April 14, 28, 11.
Winding of dynamo electric machines—US-9, March, 11.
Bakelite. Its electrical properties—US-11, March 9, 11.
Network analysis—E-3a, Feb. 24, 11.
Considerations relating to the parallel working of alternators—E-3a, Feb. 24, 11.
Latest types of mercury converter—E-3a, Feb. 17, 11.
Breaking high and low potential circuits—E-6, Feb. 24, 11.
Electrolytic corrosion of iron in concrete—US-10, March 4, 11.
Design and operation of water rheostats—US-11, March 2, 11.
Alternating current engineering—US-44b, March, 11.
A mercury vapor rectifier for large powers—E-3b, Feb. 10, 11.
Clark and Weston standard cells—E-3a, Feb. 10, 11.
Specifications and tests for insulating tape—US-1, Feb. 23, 11.
Prone pressure method of resuscitation from electric shocks and drowning—US-9, Feb., 11.
Grading of dielectrics—US-16a, Jan., 11.
Standards of capacity—US-10, Jan. 21, 11.
The centralization of power—US-43L, Dec. 10, 10.
Commercial electrical testing—US-16a, Jan.-Feb., 11.
The rise in temperature of electrical apparatus—E-3b, April 7, 11.
Winding of dynamo-electric machines—US-9, April, 11.
Electricity meters with notes on meter testing—E-3a, Mar. 24, 11.
Arc-lamp electrodes. Their composition, method of manufacture and impregnation for various classes of service—US-11, Mar. 16, 11.
Improvements in underground conduit construction—E-3a, Mar. 17, 11.
Breaking high and low potential circuits—E-3a, Mar. 17, 11.
Direct and alternating-current electromagnets—E-3b, Mar. 17, 11.
The reduced current method for localising fractures in submarine cables—E-3a, April 7, 11; US-10, April 15, 11.
High-tension cables—E-3a, April 21, 11.
A new method for the absolute measurement of electric quantity—E-3a, April 21, 11.
All about the rubber industry—US-41c, Mar., 11.
Simple method of making thermo-electric measurements of high temperature—US-11, April 20, 11.
Battery economics and battery discharge arrangements—E-3a, April 28, 11.
Alternating current engineering—US-42b, May, 11.
Telephone condensers and their uses—US-45a, April, 11.
Tests of electric cables, made by the central electrical laboratory in Paris—F-1, April 29, 11.
Submarine cable laying and repairing—US-23a, Jan.-Feb., 11.
Electrical alarm arrangements adapted to the field—G-4, No. 4, 11.
Protective apparatus against lightning for manufactories of explosives—G-10, May 1, 11.
Light:

Recent progress in electric lighting—E-3a, Dec. 23, 10.
Wiring and illuminating chart—US-11, Nov. 24, 10.
Field searchlights—US-40a, Jan.-Mar., 11.
The new era in electrical illumination—US-13, Dec., 10, Jan., 11.
Notes on electric lighting—US-16a, Dec., 10, Jan., Feb., 11.
Experiments with electric bulbs with metallic filaments to determine their resistance to shock—I-1, Oct. 16, 10.
Three-phase arc lamp with four carbons—E-3a, Oct. 7, 10.
Searchlights for military and naval use—F-1, Jan. 7, 11.
The manufacture of carbons for electric lights—E-3b, Jan. 20, 11.
New metallic filament lamps—US-22, April, 11.
Nocturnal warfare. An automobile-mounted searchlight for the French army—US-42, April 8, 1911.
Arc-lamp electrodes—E-3b, April 21, 11.
Principles of illuminating engineering—US-42b, May, 11.
The efficiency of metal filament lamps—E-3a, April 28, 11.
Power:
Elements of power-station design. Underground transmission—US-10, Dec. 3, 10, 10.
Elements of power station design. Lightning protection—US-10, December 31, 10.
Recent developments in induction motor design—E-3b, Dec. 16, 10.
Elements of power station design. Overhead transmission and line calculation—US-10, Dec. 24, 10.
The Cathode equilibrium in the Weston standard cell—E-3a, Oct. 21, 10.
Elements of power station design. Installation details—US-10, November 19, 26, 10.
Some types of circuits for voltage, current and power control—US-10, Nov. 19, 10.
Elements of power station design. Distributing system—US-10, Feb. 4, 11.
Recent developments in small direct current motor design—US-16a, Jan., 11.
Winding of dynamo-electric machinery—US-9, Jan., 11.
Testing and calibration of watt-meters—US-42b, May, 11.
Grounded and ungrounded transmission circuits—US-9, May, 11.
Winding of dynamo-electric machines—US-9, May, 11.
Storage Batteries:
Thomas A. Edison's latest invention. A storage battery designed and constructed from the automobile user's point of view—US-42, Jan. 14, 11.
Jarman's system of electric traction by storage batteries—US-43L, Jan. 14, 11.
The 1910 Edison storage battery—US-10, Dec. 3, 10; E-3a, Oct. 21, 10.
The new ironclad-exide battery for electric vehicles—US-22, March, 11.
Notes on lead storage batteries for submarine use—US-20, Feb., 11.
Elements of power station design. Storage battery plants—US-10, Feb. 18, 25, March 4, 11.

BOILERS

Boiler economics—E-6, Jan. 13, 11.
Boiler economics and the use of high gas speeds—E-11, Dec. 23, 30, 10 and Jan. 6, 13, 20, 27, 11.
Separation of oil from condenser water by electrolysis—E-3a, Dec. 30, 10.
A case of marine superheating—E-4, Nov. 18, 10.

Practical economy of smoke prevention—US-13, Dec., 10.
High and low water alarms for boilers—US-43L, Nov. 5, 10.
Marine boilers—US-30, Feb., 11.
The clinkering of coal in boiler furnaces—US-13, Feb., 11.
Practical notes on the working and control of steam boilers—US-11, Feb. 2, 11.
Causes of deterioration in boilers—E-11, Jan. 27, 11.
Comparative coal tests—US-23a, Mar.-April, 11.
Natural and artificial draft—US-22, May, 11.
The working of a CO_2 recorder—E-3b, Abril 14, 11.
Entropy—US-26, Mar., 11.
Fuel oil *versus* coal—US-40a, April-June, 11.
Good coal and poor—US-42, April 15, 11.
Smoke prevention—E-3b, April 7, 11.

ENGINES

Gas:

An ocean-going oil engine ship—E-4, Jan. 13, 11.
Powerful light motors for aeroplanes—US-43L, Nov. 19, 10.
Automobile cylinder lubricating oils—US-42, Jan. 14, 11.
American producer gas practice—US-44a, Jan., 11.
A new German gas engine. Details of the double-acting four-cycle engine built by Ehrhardt and Sehmer—US-17, Jan. 5, 11.
Gas power development: A review—US-15, Dec. 22, 10.
Some pertinent features relating to gas power—US-9, Jan., 11.
The N.E.C. two-cycle aeroplane engine—E-11, Jan. 6, 11.
The Diesel motor—A-2, Dec., 10.
Aeroplanes and airship engines—US-27, Jan., 11.
Internal combustion motors and the navy—F-12, Sept. 3, 10.
Scientific error and gas-engine design—E-4, Dec. 9, 10.
Thirty-six brake-horse-power gas-engine at the Smithfield club show—E-5, Dec. 9, 10.
The Nuremberg gas engine—E-11, Nov. 25, 10.
Six-hundred horse-power Diesel engine—E-5, Nov. 25, 10.
Steam power and gas power—E-5, Nov. 25, 10.
Pistons for petrol motors—E-5, Dec. 16, 10.
Gas producer design and operation—US-17, Nov. 17, 10.
Power gas and its development—E-3a, Oct. 21, 10.
Large two-cycle gas engines—E-4, March 3, 11.
Heavy oil engines for marine purposes—US-28, March, 11.
The lubrication of cylinders of motors of great power—I-1, Feb. 1, 11.
The racing of internal combustion engines at sea—E-4, Feb. 24, 11.
The gas turbine. A consideration of proposed types—US-43L, Feb. 18, 11.
Gas power development. The possibilities of an important prime mover—US-43L, Feb. 18, 11.
The oil engine in marine work—US-20, Feb., 11.
Aviation and aeroplane motors—E-11, Feb. 24, 11.
Internal-combustion engines at the Brussels Exposition—US-8, Feb., March, 11.
Carburetters and vaporisers—US-8, Feb., 11.
Scientific error and gas engine design—US-43L, Feb. 11, 11.
The hydraulic ram—US-32a, Feb., 11.
Observation land mines—E-14, Feb., 11.

Utilization of gas power in the navy—Sp-3, Sept.-Nov., 10.
Airship motors—F-11a, Jan. 1, 11.
The Knight valveless motor—US-43L, Jan. 21, 11.
German combustion motors for ships—G-7, April 12, 11.
Calculating the crankshaft of a four-cylinder automobile motor—A-4, April 14, 11.
Large gas engines of the two-cycle type—E-5, Mar. 17, 24, 11; E-11, Mar. 17, 24 and April 14, 11.
Diesel marine engines—E-4, April 7, 14, 11; E-11, April 21, 11; E-3, April 14, 11; US-28, May, 11.
Remarkable economy of an oil fuel installation—US-28, April, 11.
The aero and motor-boat exhibition at Olympia. Engines for aeroplanes—E-5, April 7, 11.
Report on petrol marine motors—F-2, Dec., 10.
Increasing the efficiency of a large gas-engine plant—US-10, April 22, 11.
Power from producer gas—US-10, April 22, 11.
The Gnome engine described—US-41c, Mar., 11.
Advantages of long-stroke gasoline engines for commercial vehicles—US-15, May 4, 11.
The influence of multi-point ignition on the efficiency and output of internal combustion engines—US-0, May, 11.
Some problems relating to the use of internal combustion engines for marine propulsion—E-11, April 21, 11.
Gas-producers—E-5, May 5, 11; E-6, May 5, 11.
Gas producers: A discussion at the Institution of Mechanical Engineers—E-11, May 5, 11.
Investigation of gasoline engines with a view to determining their suitability as a source of power for coast defense installations—US-23a, Jan.-Feb., Mar.-April, 11.
The effect of varying proportions of air and steam on a gas producer—E-4, May 5, 11.
Combined gas and steam engines—US-13, May, 11.
Fuel oil *versus* coal—US-40a, April-June, 11.

Steam:

The steam turbine and its applications—I-1, Dec. 16, 10.
Modern rotary steam engines—US-43L, Nov. 26, 10.
Modern governing mechanisms. A review of American and European devices—US-43L, Jan. 7, 11.
The advantages of small exhaust-steam turbines—US-10, Dec. 31, 10.
Hints on steam raising—E-11, Nov. 25, Dec. 2, 10.
Steam power and gas power—E-5, Nov. 25, 10.
Report of test of a Babcock and Wilcox boiler for U.S. battleships *Wyoming* and *Arkansas*—US-20, Nov., 10.
Testing steam turbines and turbo-generators—US-34L, Dec., 10.
Practical evolution of the steam engine. The compound machine—F-2, Aug., 10.
The Curtis turbine—US-16a, Dec., 10.
Entropy analogy—US-11, Dec. 22, 10.
The steam turbine and its applications—I-1, Oct. 16, 10.
Practical evolution of the steam engine. The multiple expansion or compound machine—F-2, Sept., 10.

Low pressure steam turbines—US-39, Nov., 10.
Elements of power-station design. Typical steam power plants—US-10, March 11, 11.
Some steam turbine considerations—US-9, March, April, 11.
The year's progress in the design of steam turbines—E-4, Jan. 20, Feb. 10, 11.
Tables on turbine characteristics—A-4, April 7, 11.
Elements of power station design. Hydroelectric development—US-10, April 8, 11.
Determining the accuracy of indicator springs—US-8, May, 11.
Combined gas and steam engines—US-13, May, 11.
General:
Boiler economics and the use of high gas speeds—E-11, Dec. 23, 30, 10 and Jan. 6, 13, 11.
Power plant practice—E-11, Dec. 23, 10.

MECHANISM, MINES, TORPEDOES, ETC.

The Gabet torpedo—US-43L, Nov. 26, 11.
An improvement on the Mannheim slide rule—US-27, Jan., 11.
Electro-automatic mines of spherical shape—P-3, Sept.-Oct., 10.
The Siemens and Halske magneto mine-fuse igniters—US-23a, Nov.-Dec., 10.
The gyroscope and its useful possibilities—US-17, Dec. 1, 8, 15, 22, 10
Radio of action of the automobile torpedo—Sp-3, Dec., 10.
Favorable conditions for the utilization of automobile torpedoes—Sp-3, Dec., 10.
The gyroscope for marine purposes—US-28, Jan., 11.
The construction and trial of the Schneider torpedoes. The Maures battery in the roadstead of Hyères—F-1, April 8, 11.
The subterranean war (mines). (A number of sketches showing possibilities.) —A-1, No. 11, 11.
Design and application of the modern ball bearing—US-8, April, 11.
Experiments on the loss factor (power) in gearing apparatus—G-8, April 20, 11.

ENGINEERING

Cement in the tropics—E-14, Feb., 11.
Forms for concrete—US-43L, Jan. 14, 11.
Asbestos. Its production and use—US-9, Jan., 11.
An ideal fuel manufactured out of waste products—US-30L, Dec., 10.
Portland cement—E-5, Nov. 25, 10.
A "Spanish Windlass"—US-23a, Nov.-Dec., 10.
The gyroscope and its applications—US-41c, Dec., 10.
New method for determining a point at sea—I-3, Feb., 11.
The purchase of coal by specifications—US-13, March, 11.
A chart for the calculation of engineering formulæ—E-4, Feb. 24, 11.
Electrolytic corrosion of iron in concrete—US-10, March 4, 11; US-11, April 6, 11.
The effect of sea-water on cement—F-1, Feb. 11, 11.
Paints and pigments—US-26, Jan., 11.
The generation of power—E-11, Jan. 20, 11.
Timber preservation, its development and present scope—US-46, Mar., 11.
The waterproofing of masonry—US-15, Mar. 30, 11.

The micrometer alidade and its uses—US-15, April 20, 11.

Re-enforced concrete bridges on the railroad line Klaus-Agonitz—A-4, Jan. 20, 27, 11.

Portland cement: What is it? How it is manufactured from clays and limes —US-42, Mar. 18, 11.

The problem of waterproofing. The properly built concrete house in damp-proof—US-42, Mar. 18, 11.

General, Civil, etc.:

The year's progress on the Panama Canal—US-42, Nov. 26, 10.

The Panama Canal and the navy—US-31, Dec., 10.

American Institute of Mining Engineers Panama meeting—US-30, Jan., 11.

Realizing the dream of Panama—US-41, Jan., 11.

The record of a year's work on the Panama Canal—US-16, Nov. 26, 10.

Extracts from the report of the Isthmian Canal Commission for the year ending June 30, 1910—US-15, Nov. 24, 10.

The Panama Canal in 1910—E-11, Dec. 16, 23, 10.

The relation of the Corps of Engineer Officers, U.S.A., to river and harbor improvements—US-15, Dec. 29, 10.

Army Engineer's plan for raising the Maine. The design of cofferdams for very deep water—US-15, Dec. 29, 10.

Army plan for uncovering the Maine—US-42, Dec. 24, 10.

The progress of the Panama Canal—E-11, Nov. 18, 10; US-13, Dec., 10.

Locks and dams of the Panama Canal—E-4, Nov. 25, 10.

Electricity and the Panama Canal—E-3b, Nov. 25, 10.

The Panama Canal. Its general effect—E-2, Dec. 3, 10.

Naval and military strategy of the Panama Canal. Translation from the German of Count von Reventlow—US-30, Feb., 11.

Work at the Panama Canal—US-21, Jan., 11.

Fortification or neutralization (of the Panama Canal)—US-31, Jan., 11.

The Panama Canal—US-5, Jan., 11.

Approval of the Panama Canal work by members of the American Society of Civil Engineers—US-15, April 13, 11.

Military:

The profiles of field trenches—I-2, Oct., 10.

Military Engineering—US-38, Jan., 11.

A study of defilade—F-5, Dec., 10., Feb., 11.

The "perfect" loophole—E-14, April, 11.

Fortifications:

Right to fortify Panama Canal (Letter of ex-Senator Joseph B. Foraker of Ohio)—US-4, Jan. 14, 11.

Field fortifications and its application to the maneuver—I-2, Sept., 10.

Modern field fortification, the light intrenching tools of the sappers and the engineer troops—I-2, Nov., 10.

The fortifications of Flushing—S-5, Jan. 15, 22, 11.

Artillery fortification characteristics of modern coast defense—G-4, No. 2, 11.

Fortifications of the battlefield. Translated from *Revue de L'Armee Belge*, Sept.-Oct., 1910—E-7, Mar., 11.

Notes on the theory and practice of field fortification. Modifications drawn from the experience of the Russo-Japanese war—E-14, April, 11.

METALLURGY

The works of John Cockerill, Seraing, Belgium—E-4, Dec. 23, 10.
The corrosion of iron—E-4, Dec. 9, 10.
The design and application of the modern ball bearing—US-8, March, 11.
Report of the Corrosion Committee of the Institute of Metals—E-11, Feb. 10, 11.
Remarkable properties of bakelite—US-41c, Jan., 11.
The rusting of iron—US-15, May 11, 11.
The conservation of iron—E-11, April 28, 11.
Coslettizing. A new process for the rust-proofing of iron and steel—US-28a, May, 11.
Some practical experience with the corrosion of metals—US-28, April, 11.

MILITARY GEOGRAPHY

The International millionth map—US-43L, Dec. 17, 10.
The International millionth map of the world—US-30L, Feb.,10.
The significance of the North Sea—G-5, Jan., 11.
The North Sea. Its political history and military geography—F-10, Feb., 11.

HISTORY AND BIOGRAPHY

Biography:
Andre Marie Ampere—US-43L, Dec. 3, 10.
Octave Chanute—US-15, Nov. 17, 10.
Biography of Oscar Guttmann—G-10, Dec. 15, 10.
Gustavus Adolphus—E-20, Dec., 10, Jan., 11.
The Portuguese commander in the Peninsular War—P-4, Sept.-Oct., 10.
The English commander in the Peninsular War—P-4, Sept.-Oct., 10.
General Wesley Merritt—US-24, March, 11.
Notes on Lee—E-19, March, 11.
Gustavus Adolphus—E-20, Feb., 11.
Charles Proteus Steinmetz: An appreciation. A great electrical engineer—US-42, May 6, 11.
The horse in military affairs of antiquity—G-9, No. 6, 11.
Napoleon's Marshals—E-7, Mar., 11.
Battles, Campaigns, etc.:
Resplata (The Reckoning)—E-8, Nov., Dec., 10.
General Military:
The North Sea. Its political history and military geography—F-10, Feb., 11.
Russian-Japanese war—A-3, Dec., 10; F-11, Mar., April, May and June, 10.
Notes on the war in the Peninsula (1808-10) including the "Giron" diaries—E-7, Nov. and Dec., 10, and Jan., 11.
The regular army in the Civil war—US-23, Jan.-Feb., Mar.-April, May-June, 11.
Gibraltar under Moor, Spaniard and Briton—E-14, Dec., 10, and Jan., 11.
Revolutionary army orders—US-47L, Jan., 11.
Memory of our great war—US-23, Jan.-Feb., 11.
The study of war history—G-6a, Dec., 10.
The Russo-Turkish war, 1877-78—A-3, Dec., 10.
Port Arthur in 1904—G-4, Dec., 10.
Official history of the Russo-Japanese war. (Published by the General Staff of the Japanese navy)—F-10, Dec., 10, Jan. 11.

Other realities of the battlefield—the Prussian right wing at Resonville—F-9, Dec. 15, 10.
Orderly book of General John Peter Gabriel Muhlenberg, March 26-December 20, 1777—US-31a, Oct., 10.
Jefferson's recollections of Patrick Henry—US-31a, Oct., 10.
Our citizen army. (England)—E-10a, Dec., 10.
The Portuguese Infantry at Bussaco—P-4, Sept.-Oct., 10.
The operations around Melilla in 1909—F-11, Feb., Mar., April, 10.
The Portuguese cavalry in the campaign of 1810-11—P-4, Sept.-Oct., 10.
The battle of Neuenegg, 5th March, 1798—S-2, Nov., 10.
Greece, Turkey and the war of 1897—S-6, July-Aug., 10.
Notes for promotion examinations on the Franco-German war—E-7, Nov., 10.
Centenary of the battle of Bussaco—P-1, Sept., 10.
Bussaco, battle of—P-4, Sept.-Oct., 10.
An account of the retreat from Danevirke in 1864—Sc-2, Feb. 1, 1908.
The Peninsular war and its centennial—P-2, Sept., 10.
Von Moltke in August, 1870—E-19, March, 11.
The American Civil War—E-19, March, 11.
History of the French-Swiss Guard regiment—S-2, Feb., 11.
The Civil War fifty years after—US-41, March, 11.
Photographing the Civil War—US-41, March, 11.
The "Events in Alsace"—E-7, Feb., 11.
The siege of Port Arthur—E-7, Feb., 11.
The Engineers at Port Arthur—G-4, Sept., 10.
The progress and failure of the expedition from Canada, June to October, 1777—E-8, Jan., 11.
Cause and effect in the Franco-German war—E-9, Jan., 11.
The campaign of Bull Run, 1861—E-9, Jan., 11.
Soult's retreat from the Baztan Valley in 1813—E-9, Jan., 11.
The Valley and other campaigns—E-20, Feb., 11.
Wa-fan-gon (14th and 15th June, 1904)—F-1b, Jan. 1, 11.
Port Arthur sanitary service—A-1, No. 5, 11.
An unpublished report of Magellan's trips around the world—G-5, No. 4, 11.
Port Arthur 1904.—The engagements on the more advanced foreground—G-4, No. 3, 11.
Russia's supply department in the campaign 1904-05—A-3, Nov. 1, 10.
The Russo-Japanese war. An instruction of Kuropatkin hitherto unpublished—A-3, No. 1, 11.
Mesko's division at Dresden 1813—A-3, No. 2, 11.
Compulsory training in schools—E-10a, Jan.-Mar., 11.
The war between the U. S. and Mexico in 1846-8—F-0, April 20, 11.
Extracts from the Journal of Surgeon Ebenezer Elmer of the New Jersey Continental line, September 11-19, 1777—US-31a, Jan., 11.
Orderly book of General John Peter Gabriel Muhlenberg, March 26-December 20, 1777—US-31a, Jan., 11.
Some personal experiences of a Russian officer at Mukden—E-20, May, 11.
The Roman imperial army—E-20, May, 11.
The work of the General Staff on the seven years' war—G-6, April 20, 11.
The Japanese in Manchuria—F-9, April 15, 11.
The French offensive in Eastern France—Dec., 1870 to January 1871—G-6a, No. 1, 11.

The final struggle for 203-Meter Hill at Port Arthur—US-40a, April-June, 11.
The Crimea revisited—E-7, Mar., 11.
Hancock and the Vermont Brigade—US-23, Mar.-April, 11.
Types and traditions of the Old Army—US-23, Mar.-April, 11.
The Russian Artillery in Eastern Asia—G-1, No. 51, 11.
War experiences in South West Africa—G-6, Beiheft, No. 3, 11.
Bernadotte and the Saxons at Wagram July 5-6, 1809—G-6, Beiheft, No. 1, 11.
The battle of Kolin on June 18, 1757—A-3, No. 1, 11.
Baden troops in Spain during the years 1808 to 1814—G-6, Beiheft, No. 4, 11.
The battle of Barossa, March 5, 1811—G-6, March 9, 11.
The Boer War and its lessons from the German and English point of view—G-6, Nos. 4, 25, 26 and 27, 11.
The first English-Dutch war (1652-1654)—G-5, No. 4, 11.
Other realities of the battlefield—the Prussian right wing at Rezonville—F-9, April 15, 11.

General Naval:

The defense of Corfu in 1716—G-6a, Dec., 10.
The blockade of Brest, 1793 to 1805—G-9, Jan., 10.
The Official (Naval) History of the Russo-Japanese War (4th part), by the Japanese Naval General Staff (Trans. into French)—F-10, Feb., Mar., 11.
Rasplata (The reckoning)—E-8, Jan., 11.
Official history of the Russo-Japanese naval war—Sp-3, Sept., Oct., Nov., Dec., 10.
Naval battle of St. Nicholas—M-1, Feb., 11.
Port Arthur. Events at sea, 1904—G-4, No. 1, 11.
Blake's last campaign (1656-57)—E-20, May, 11.
Prussian privateering in the Seven Year's War—G-5, No. 22, 11.

MILITARY SCHOOLS

The West Point Academy—E-7, Jan., 11.
Advanced military studies in France—F-4, Dec., 10.
Organization of the war college 1660 (Denmark)—Sc-2, Nov. 15, 10.
The Mechanical Specialists, Coast Artillery Corps—US-23a, Nov.-Dec., 10.
American officers at Saumur—US-24, Jan., 11.

ORGANIZATION AND ADMINISTRATION

Coast Defense:

The coast defenses of Holland—F-0, Dec. 31, 10, Jan. 1, 7, 11.
The fortifications of Flushing from an international point of view—S-5, Dec. 18 and 25, 10, and Jan. 1, 29, Feb. 19, 26, 11; F-0, Feb. 6, 11; S-2, Feb., 11.
Organization of the Austrian fortress artillery—G-1 Dec., 10.
Austrian mountain troops—G-9, Jan., 11.
Effects on coast defense of the naval developments of the last few years—US-23a, Nov.-Dec., 10.
Permanent fortifications (*Precis* from Von Löbell's reports, 1909)—E-8, Feb., 11.
Flushing and the freedom of the Scheldt—S-5, Feb. 5, 11.
Italy's coast defense—G-4, Sept., 10.
The problem of the Scheldt fortification—E-19, Feb. 2, 11.
An artillery command line telephone exchange—E-7, April, 11.
The Flushing question—F-1b, April 1, 11.

Dutch coast defense—E-7, Mar., 11.

Russian coast defenses—E-2, Mar. 25, 11.

The defense of the land front of a coast fortress, with particular reference to the method of utilizing the mobile guns allotted to the general defense —E-7, April, 11.

Russia's plans of coast defense—G-6, Mar. 18, 11.

Artillery fortification characteristics of modern coast defense (concluded)—G-4, No. 3, 11.

Instruction of coast artillery corps, Rhode Island national guard—US-23a, Mar.-April, 11.

Field Artillery:

Cavalry machine-gun sections after 4 years experience—F-6, Feb., 11.

The organization of horse artillery—G-1, Nov., 10.

Organization of Japan's artillery—G-1, Nov., 10.

Organization of field artillery in Austria, France, Germany and Switzerland at the beginning of 1911—I-2, Jan., 11.

The Italian regulations on mountain transportation of siege guns—A-2, No. 2, 11.

Artillery observations and the employment of telephone stations (continued) —A-2, No. 2, 11.

Morals and maxims for stable management and horse mastership—E-7, April, 11.

Army:

Indian (Native) army reserves—E-9, April, 11.

Progress of foreign armies 1910 (France, Italy)—A-3, No. 3, 11.

Army—England:

British Imperial Committee of Defense—F-11, Mar., 10.

The English military forces in the spring of 1909—F-11, July, 09.

The problem of Imperial defense (British)—E-3, Feb. 28, 11.

The defense of the British Empire. Military and naval organization in Australia—F-1b, Jan. 15, 11.

The British officer's pay—E-2, May 6, 11.

The cavalry of the British army—US-24, May, 11.

How can the colonies best help in the defense of the empire? (British)—E-8, April, 11.

Army estimates 1911-12. (English Army)—G-6, Mar. 21, 11.

Army organization in England and the question of invasion—G-5, No. 3, 11.

Army—Germany:

Military report of the German Empire—S-1, Feb. 25, 11.

German ideas on cavalry—F-6, Oct., 10.

Army—France:

The rules of May 25, 1910, for the interior economy of troops. (France)—F-6, Aug.-Sept., 10.

Organization of infantry for service, under the new law (France)—F-1b, Feb. 15, March 1, 15, 11.

The military power of France—F-0, April 14, 11.

Army—Russia:

The present state of the Russian army—E-8, Dec., 10.

Recent changes in the Russian army—F-11, Dec., 10.

The reorganization of the Russian army—G-6, Dec. 17 and 31, 10.

Reforms in the Russian army since war in Manchuria—F-11, Nov., 09.

Changes and tendencies in the Russian army since the war against Japan—E-8, Nov., 10.

Recent accounts of the Russian artillery organization, armament and tactics—Sc-1, No. 6, 10.

The reorganization and redistribution of the Russian army—F-0, Jan. 25, Feb. 2, 7, 15, 11; E-2, Mar. 25, April 15, 11.

The Russian army: I. Volunteers. II. The "Urussowschen" course, as a preparation for the military academy—G-6, April 15, 11.

Army—Japan:

Instruction of officers and noncommissioned officers in the Japanese army—F-0, April 13, 11.

Army—Minor States:

A few days with Turkish troops—S-2, Dec., 10.

The Roumanian army—S-3, Dec., 10.

The organization of the Norwegian army, 1789-1810—Sc-4, No. 11, 10.

Organization of the army (Switzerland)—S-2, July, 10.

Military Institutions of Peru—F-11, Dec., 09.

The new Belgium military law of December 14, 1909—F-11, Feb., 10.

The Chinese army, March 1, 1910—F-11, May, 10.

The Swedish army in 1910—F-11, June and July, 10.

New organization for Danish national defense—F-11, Jan., Feb., 10.

The Turkish army in 1909—F-11, June, 09.

Reorganization of the Portuguese army (after the formation of the republic) —P-3, Sept.-Oct., 10.

The proposed Swiss army organization—S-2, Sept., Nov., 10.

Mounted machine-gun detachments in Holland—S-2, Jan., 11.

In the Japanese army—S-1, Feb. 25, 11.

Holland's system of defense and the Vlissinger question—S-1, Feb. 18, 11.

The Turkish army I and II—G-6, April 4, 11.

Reorganization of the Norwegian army—G-6, Nos. 25 and 28, 11.

The Grecian army—S-1, Mar. 4, 11, 18, 11.

The coming organization of Swiss artillery and engineer corps—G-4, No. 1, 11.

Belgium's land defense in 1870 and now—G-9, May, 11.

Army—United States:

The U.S. army in 1909—F-11, Sept., Oct., Nov., 09.

The Army and the National Guard from the view point of a National Guard officer—US-29, Jan., 11.

The Quartermaster's department and its relation to the organized militia—US-2, Jan. 19, 26, 11.

Uncle Sam's ammunition factory (Frankford Arsenal)—US-2, April 27, 11.

The necessity of a general staff in the state militia—US-16d, Jan. Mar., 11.

Plan for the organization of regiments of cavalry, field artillery and infantry US-23, May-June, 11.

Conditions responsible for the inefficiency of the organized militia and their cure—US-23, May-June, 11.

Notes on guard duty—US-23, Mar.-April., 11.

How far in time of peace should the authority of the United States be further extended over the organized militia of the various states and territories—US-23, Mar.-April, 11.

The American officer—S-1, May 6, 11.
The military policy of the United States—US-30d, April, 11.

General Military:

Preparedness for war—A-3, Nov., 10.
Statistics regarding the offensive and defensive strength of different nations of the world—Sc-2, Feb. 1, 1908.
Freedom of action of commanding generals—F-1b, March 1, 11.
The technique of command (orders)—A-3, April, 11.

Technical Troops:

Military communications—US-2, Jan. 12, 11.
Bicycle troops in Italy—G-6, Dec. 10, 10.

Transport and Supply:

New field kitchen of the German army—US-4, Jan. 7, 11.
The army ration—US-2, Dec. 1, 10.
Field train service of a German army corps—F-11, Nov., 09.
Conformation and choice of the cavalry horse—F-6, Oct., 10.
The supply of ammunition to the firing line—G-1, Nov., 10.
French supply of ammunition—A-2, Nov., 10.
Notes on the embarkation and disembarkation of mules—E-14, Feb., 11.
The Quartermaster's department and its relation to the organized militia—US-2, Jan. 26, 11.
Russia's supply department in the campaign of 1904-05—A-3, No. 1, 11.
Auto-trucks for the army—US-23, Mar.-April, 11.
The new German army bedstead—A-4, May 5, 11.
Army transport docks at San Francisco—US-28, May, 11.

Medical:

The Swiss sanitary corps—A-3, Dec., 10.
The reorganization of the sanitary service—S-5, Nov. 6, 10.
The new field sanitary regulations (French)—F-0, March 11, 11.
The prevention of typhoid fever—US-29, March, 11.
The sanitary corps in 1870-71—G-6a, Oct., 10.
The sanitary officer—US-29, Feb., 11.
John Brown of Kansas—US-8c, Feb., 11.
Lessons learned at a maneuver camp—US-29, Jan., 11.
Port Arthur—sanitary service—A-1, No. 5, 11.
An outline of the organization of the Medical Department of the Japanese navy—US-29, May, 11.
What measures should be adopted for effective prevention of unsanitary conditions in the early stages of volunteer camps in time of war—US-23, May-June, 11.
The founding and development of the Red Cross by Henri Dunant and Gustav Moynier—G-6, Beiheft, No. 1, 11.
Requirements in construction of hospitals considered in the medical and hygenic relations—A-4, April 7, 11.
Death rates in the Japanese war—US-4, May 6, 11.

RECONNAISSANCE AND SKETCHING

Instruction of scouts and agents—US-16d, Jan.-Mar., 11.
Military patrols of skiers—S-2, April, 11.

SIGNALLING

A plea for more signallers—E-7, Jan., 11.
Military communications—US-2, Jan. 6, 11.
An improvised ardois—US-23a, Nov.-Dec., 10.
An improved semaphore flag—E-7, Nov., 10.
The new Dosne heliograph—US-42, Nov. 19, 10.
Telephone and signal stations—A-2, Nov., 10.
Signalling in the French army—US-23, May-June, 11.
The employment of visual telegraphy (signalling) for the transmission of military information—G-4, No. 3, 11.
Electrical alarm arrangements adapted to the field—G-4, No. 4, 11.

SMALL ARMS AND EQUIPMENTS

Small Arms:

The Westley Richards air pistol—E-1, Dec., 10.
Rose's electric recording target—E-3a, Dec. 9, 10.
A field practice sub-target (small-arm)—E-14, Dec., 10.
The Moore silencer (small-arm)—S-2, Oct., 10.
The Maxim silencer and its effect upon future military operations—US-25, Nov., 10.
Silencer for military rifles—US-43L, Dec. 3, 10.
Some original and different suggestions for the National matches—US-2, Dec. 29, 10.
The rifle *versus* the "Arme Blanche"—E-20, Jan., 11.
The effect of light and mirage—US-2, Dec. 8, 10.
Vented barrels—US-2, Dec. 22, 29, 10.
Sharp pointed bullet in Austria—I-2, Nov., 10.
Small arms in present use and their ammunition—F-1b, March 1, 11.
Modern military rifles—E-2, Jan. 21, 28, Feb. 4, 18, 11.
Small arms and ammunition—F-1b, Feb. 15, 11.
The rifle telescope-limitations—US-2, March 1, 11.
A close sight of a new sight—US-2, Feb. 23, 11.
An electric recording rifle range target—US-42, Feb. 11, 11.
Report mufflers for firearms—US-42, Jan. 28, 11.
Muzzle venting report, 1910—US-2, Mar. 16, 11.
Smallarms development in 1909—Sc-3, No. 6, 10.
Fire arms and ammunition of armies of the present day—F-1b, March 15, April 1, May 1, 11
The automatic rifle—US-25, March, 11.

Equipments:

The equipment of German cavalry—S-3, Dec., 10.

STRATEGY AND TACTICS

Strategy:

A study of strategy. (16th Aug., 1870.)—F-6, Aug.-Sept., 10.
The Austro-Italian frontier and the Adriatic—F-11, Mar., April, May, 09.
The strategy of Napoleon and that of Moltke—E-20, May, 11.

Tactics—Artillery, Coast:

Effects on coast defense of the naval developments of the last few years—E-7, Nov., 10.

Tactical-technical considerations on the armament and supply of seacoast batteries—I-2, Nov., 10.

German instructions for siege warfare—F-11, Feb., 11.

Artillery lessons learned at Port Arthur—G-1, Oct., 10.

Action of coast artillery against a squadron—M-2, Sept. 30, 10.

Effects on coast defense of naval developments of the last few years—US-23a, Jan.-Feb., Mar.-April, 11.

Artillery fortification characteristics of modern coast defense—G-4, Nov. 2, 11.

Tactics—Artillery, Field:

The employment of artillery at the battle of Sha-Ho—E-7, Nov., 10.

Use and abuse of artillery in the Russo-Japanese war—E-7, Nov., 10.

The co-operation of field artillery with infantry in 1870-71 and at the present time—E-7, Nov., 10.

The employment of mountain artillery according to the English rule—I-2, Sept., 10.

Firing under cover by the field artillery—Sc-2, March 15, 08.

French and English artillery methods—E-20, Dec., 10.

Tactical use of field artillery—G-6, Dec. 15, 10.

Field artillery in future wars—A-3, Dec., 10.

A divisional artillery staff in the field—E-7, Jan., 11.

Tactical deductions from the employment of field artillery in the Russo-Japanese war—I-2, Oct., 10.

Firing instructions for the field artillery of the principal armies—I-2, Oct., 10.

Mountain horse artillery—E-7, Jan., 11.

Use of modern artillery—G-1, Dec., 10.

The technique of artillery command. Field and heavy artillery in field warfare—E-7, Jan., 11.

French views on the tactical employment of field artillery—E-12a, Jan. 6, 11.

Night field artillery maneuvers—Sc-2, Jan. 15, 11.

Employment of field artillery in battle—I-2, Nov., 10.

The artillery duel—G-1, Nov., 10.

Systematic presentation of the efficiency of the battery commander in covered positions—G-1, No. 49, 11.

Field artillery fire—US-25, Mar. 11.

Artillery in the Russo-Japanese war—A-2, No. 1, 11.

The French field artillery in action according to the Provisional Drill Regulations of September 8, 1910—G-6, Jan. 12, 14, 11.

The study of taking (occupying) a position in the artillery branch of the service—G-1, No. 51, 11.

The division of the field artillery in forest fighting—G-6, Mar. 30, 11.

A contribution to the rules for the employment of field artillery in battle—E-7, April, 11.

Artillery in action against fortified positions (Fortresses)—G-4, No. 3, 11.

The employment of Q. F. artillery—E-10a, Jan.-Mar., 11.

Howitzers with the field army—S-4, No. 4, 11.

The repulse of cavalry attacks by field artillery—G-1, April, 11.

Can machine guns serve as a support for artillery—A-2, No. 5, 11.

What influence may the field artillery have on the course of an action in a coming war?—G-1, April, 11.

Tactics—Cavalry:

German ideas on cavalry—F-6, Nov. and Dec., 10.

Cavalry fire—S-1. Dec. 17. 10.

Cavalry attack—S-4. Dec., 10

Mounted and foot combat in American and European cavalry—US-24. Jan., 11.

The employment of cavalry during the Russo-Japanese war—Sc-2, Nov. 1, 10.

Cavalry and aviation—F-5, Oct. 30. 10.

Fighting on foot—F-6. Jan., Mar., 11.

Raids and incursions of cavalry—G-9, No. 6, 11.

Service and employment of the divisional cavalry—A-3, April, 11.

The repulse of cavalry attacks by field artillery—G-1, April, 11.

A proposed method of linking and dismounting to fight on foot—US-24, May, 11.

Tactics—Infantry:

The new Russian infantry combat regulations—F-9, Dec. 15, 10.

Study of the battle on foot—F-6, Dec., 10.

Infantry fire—S-5, Nov. 6, 13, 27 and Dec. 11, 10., Jan. 15, 11.

The handling of infantry acting on the offensive—M-2, Mar. 31, 11.

The attack of the German, French and Russian infantry according to the latest regulations—G-6, Mar. 11, 11.

Conception of efficiency of rifle fire—US-23, Mar.-April, 11.

Critical review of infantry development—S-1, Nos. 1 and 2, 11.

Tactics—General:

Infantry and artillery in battle—G-6, Dec. 10, 10.

Attack of airships—G-6, Dec. 15, 10.

Moltke's war studies—G-6, Dec. 15, 10.

The use of aeroplanes in future wars—G-6, Dec. 31, 10.

Fighting on foot—F-6, Dec., 10.

The attack of a fortress—G-1, Dec., 10.

The necessity of howitzers in a siege—G-1, Dec., 10.

The doctrines and the evolution of tactics—F-1b, Dec. 15, 10.

Fortress warfare of the future—E-8, Dec., 10.

A Russian view of the support of the decisive infantry attack by the artillery. Pack artillery recommended—E-7, Jan., 11.

All arms in the attack—F-4, Nov. 1, 10.

Study of the preliminary combat—F-1b, Dec. 1, 10.

The cavalry of the future—E-20, Dec., 10.

The role of cavalry—E-20, Dec., 10.

German ideas on tactics—US-25, Nov., 10.

Transformation of war tactics in the last 40 years—M-6, August, 10.

The artillery in the general rules for the employment of large units in war—I 2, Sept., 10.

General instructions for siege warfare in France—I-2, Sept., 10.

Co-operation in the attack—F-4, Oct. 2, 10.

To what extent can infantry rely on artillery to support its attack—E-7, Nov., 10.

Co-operation of infantry and artillery—S-2, July, 10.

Initiative and the power of maneuver—E-12a, Dec. 5, 10.

Present tactical tendency in the Italian service—F-11, Feb., 11.
Night attacks—G-4, Sept., 10.
Artillery supporting infantry—A-2, Oct., 10.
Attack of fortified places—G-6, Oct. 22, 25 and 27, 10.
Artillery in relation with infantry—Sp-1, Nov., 10.
The lessons that can be drawn with regard to the leading of hastily and imperfectly trained troops, from the experience of the operations in the eastern theatre of the American Civil War, up to May 5, 1863—E-8, Jan., 11.
Upon the battlefield. Study of the combined action of the three arms—F-6, Jan., Feb., 11.
Applied minor tactics—US-2, Feb. 9, 11.
Tactical use of the machine gun—F-1b, Jan. 15, Feb. 1, 11.
Preliminary work in action for prepared positions (continued)—A-2, No. 2, 11.
The cooperation of the arms in battle—US-16d, Jan.-Mar., 11.
Different views on the manner of supporting infantry by artillery during an attack—G-1, No. 50, 11.
Reasons for construction of guns for defense against balloons—G-4, No. 1, 11.
Mounted troops in cooperation with other arms—E-12a, Feb. 21, 11.
Royal engineers in cooperation with other arms—E-12a, Jan. 17, 11.
Artillery in cooperation with infantry—E-12a, Dec. 6, 10.
Fundamental principles in irregular warfare—E-7, April, 11.
Means for illuminating the foreground both far and near. Viewpoints for their tactical utilization in fortress warfare (defense)—A-3, No. 3, 11.
Use of engineer troops on the field of battle—F-8, Mar., 11.
The subterranean war (mines). A number of sketches showing possibilities —A-1, No. 11, 11.
The influence of aviation on tactics—E-20, April, 11.
Analogy between the tactics of field and fortress warfare—I-2, Dec., 10.
The new German instructions for fortress (siege) operations—E-14, April, 11.
Impatience on the battlefield—G-6, April 13, 11.
The attack by the German, French and Russian infantry according to the latest regulations—G-6, Mar. 14, 16, 11.
Fire action—E-12a, March 14, 11.
The three arms on the field of battle—F-6, Mar., 11.
Guidance and personal equations (individuality) in fortress warfare—G-6, Beiheft, No. 4, 11.
The question of firing over ones own troops—G-6, Mar. 4, 11.
"Covered positions"—G-1, No. 50, 11.
Fortress warfare—F-0, April 27, 11.
Tactical principles—F-1b, May 1, 11.
Tactics—Naval:
Salamis—A study in naval warfare—G-5, (Sup), Dec., 10.
Use of aeroplanes in naval warfare—A-1, Jan., 11.
The tactical use of torpedo boats—M-5, Aug., 10; US-40, Dec., 10; F-10, Mar., 11.
Blockade and naval warfare—G-9, Nov., Dec., 10.
Tactics and Dreadnoughts—A-1, No. 5, 11.

SUBMARINES AND TORPEDOBOATS

Submarines:
Submarines—A-1, Jan., 11.
Exhibition of safety apparatus for submarines—F-1, Dec. 17, 10.

The Laurenti submersible—E-11, Dec. 30, 10.
The development of the submarines—F-10, Nov., 10; US-43L, Jan. 14, 11.
The cruise of the submarine torpedoboat *Salmon* from Quincy, Mass., to Hamilton, Bermuda and return, July 5-17, 1910—US-20, Nov., 10.
Tests of submarines—F-12, Nov. 5, 10.
The submersible—M-1, Nov., 10.
The salvage of submarines—F-12, March 4, 11.
Description and trial date of torpedo-boat destroyers—US-20, Feb., 11.
Description and trials of U. S. torpedo-boat destroyers *Roe* and *Terry*—US-20, Feb., 11.
Krupp-Germania submersibles—M-1, Oct., 10.
The development of submarine boats—US-43L, Jan. 21, 11.
The rescue of a sunken German submarine. How the *U3* was raised by a special floating dock built for that purpose—US-42, Jan. 28, 11.
Submarines:
Loss of Submarine No. 6, (Japanese translation)—M-4, Feb. 28, 11.
General characteristics of periscopes—M-1, Jan., 11.
The Laurenti submersible—US-23a, Mar.-April, 11.
The salvage of the German submarine U3—A-1, No. 5, 11.
Submarines of recent times—G-9, No. 5, 11.
The submersible *Kobben* for the Norwegian navy—US-42, Mar. 25, 11.
The salvage of H. M. submarine *U3*—G-5, No. 3, 11.
Torpedo Boats:
The torpedo boat—F-10, Dec., 10.
Tactical use of torpedoboats—A-1, Nov., 10.
The relative strength in torpedo craft of the British and German navies—E-4, April 28, 11.

WARSHIPS

Length of usefulness of naval ships and the naval program (France)—F-12, Dec. 24, 10.
The oil engine on shipboard—US-43L, Dec. 24, 10.
The big guns of the Dreadnoughts—F-10, Dec., 10.
Further development of battleships—A-1, Dec., 10.
Armament for battleships—G-5, Jan., 11.
Italy's triple turrets—G-5, Jan., 11.
New ships of the various fleets—G-5, Jan., 11.
Development of the Dreadnoughts—A-3, Nov., 10.
The Diesel engine ship *Vulcanus*—E-4, Jan. 6, 11.
Triple turrets—G-7, Dec. 14, 10.
Naval guns. A summary of progress—US-40, Dec., 10.
A case of marine superheating—E-4, Nov. 18, 10.
Notes on the armaments of battleships—US-28, Dec., 10.
Big guns and secondary batteries for battleships—US-15, Dec. 15, 10.
The worlds *Dreadnoughts*—E-2, Jan. 14, 11.
An ocean-going oil engine ship—E-4, Jan. 13, 11.
Dreadnoughts. What are they? The ultimate efficiency in battleship design—US-13, Jan., 11.
A critical discussion of gun power and gun arrangement in battleships—US-18, Jan., 11.
Modern means of marine propulsion—I-3, Dec., 10.

Naval shipbuilding in 1910 (British)—E-5, Dec. 30, 10.

Four recent types of dreadnoughts. A discussion of their comparative merits—US-43L, Dec. 31, 10; US-42, Dec. 24, 10.

The output of naval ordnance in England and Germany—E-4, Dec. 30, 10.

Armament of battleships—E-4, Dec. 2, 9, 16, 10.

Effects on coast defense of the naval developments of the last few years—US-23a, Nov.-Dec., 10.

New warship design—US-23a, Nov.-Dec., 10.

Naval engineering progress—US-20, Nov., 10.

Comparative performance data of recent destroyers—US-20, Nov., 10.

Description and trials of torpedoboat destroyers *Paulding* and *Drayton*—US-20, Nov., 10.

Submarines and battleships—F-12, Oct. 22, 10.

Destroyers and squadrons—their military role—F-12, Sept. 17, 24, 10.

The structure of vessels in relation to the effects of subaqueous weapons—I-3, Nov., 10.

Progress of naval artillery in the great foreign navies (foreign to Germany). Translated into French from the German of Nauticus—F-10, Feb., 11.

Offensive power of the armaments of recent dreadnoughts—F-12, March 11, 11.

Old battleships as permanent forts. Coast defenses *versus* the scrap heap—US-42, March 11, 11.

The rôle of aviation in the navy—F-10, Jan., 11.

Propulsion by Diesel oil engines—US-20, Feb., 11.

The oil engine in marine work—US-20, Feb., 11.

Electric propulsion of naval vessels—US-20, Feb., 11.

The economic advantages of the reduction gear as applied in the propulsion of naval vessels—US-20, Feb., 11.

Ships under construction in 1910 in various countries—I-3, Jan., 11.

The fleets of the near future—I-3, Jan., 11.

Experiments with guns *versus* armor (The *Kathadin*)—US-3, Feb. 18, 11.

"*Tirs d' honneur*" of the French fleet in 1910—F-12, Feb. 4, 11.

The evolution of the battleship—P-4, Jan., 11.

The new dreadnoughts—G-9, Dec., 10.

The armament of battleships. Sir William White's views—US-43L, Feb. 4, 11.

Naval ordnance and smokeless powder—E-5, Jan. 27, 11.

Warships launched and laid down in 1910—E-4, Jan. 27, 11.

Fighting efficiency of battleships—E-4, Jan. 27, 11.

Aeroplane flies to warship—US-4, Feb. 4, 11.

Fleets of England, Germany and Austria compared—F-0, Jan. 23, 11.

The armament of warships—M-1, Sept., 10.

Warships tonnage and sea strength of powers—US-31, Jan., 11.

Naval progress in 1910—E-11, Feb. 3, 11.

The aeroplane in naval warfare—F-11a, Jan. 1, 11.

Utilization of gas power in the navy—Sp-3, Sept., Nov., 10.

Construction, management and organization of modern warships—Sp-3, Sept., Oct., Nov., 10.

Diesel engines for sea-going vessels—E-4, April 14, 11; E-3, April 14, 11; E-11, April 14, 11.

Diesel engines for ship propulsion. European developments—US-15, April 27, 11.

The problem of size in battleships—E-5, April 7, 11; E-11, April 21, 11.

Effects on coast defense of the naval developments of the last few years—US-23a, Jan.-Feb., Mar.-April, 11.

The new armor—US-42, May 13, 11.

Influence of the ship's dimensions on the stability of the ship—G-7, April 26, 11.

German combustion motors for ships—G-7, April 12, 11.

Frahm's scheme for reducing the rolling of ships—I-1, Mar. 16, 11.

The gyroscope for marine purposes—E-5, March 31, 11.

Armaments and arbitration—E-5, Mar. 17, 11.

Institution of Naval Architects. The problem of the size of battleships—E-4, April 7, 11.

Armor plate advance. (Referring to firings trial against the *San Marcos*, which was the *Texas*, U. S. Navy)—E-2, April 8, 11.

The power and protection of battleships—E-4, April 7, 11.

Report on petrol marine motors—F-2, Dec., 10.

Four recent types of dreadnoughts—US-23a, Mar.-April, 11.

New ideas in naval construction—M-4, Feb. 28, 11.

A new type of ship for coast defense (Super-dreadnought)—M-1, Feb., 11.

The future development of the battleship. (Translated into French from the *Mitteilungen aus dem Gebiete des Seewesens*)—F-10, March, 11.

Battleship *versus* destroyer. The struggle between the big gun and the high-speed torpedo—US-42, April 22, 11.

Results of trials of the anti-rolling tanks at sea—E-3, April 14, 11.

Secondary naval armament—F-12, April 15, 11.

Progress in artillery 1909-10. (Translation into German of extracts from Brassey's annual)—A-1, No. 4, 11.

Improvements in nautical instruments—G-5, No. 4, 11.

Report on the behavior of the compass on H. M. S. *Nurnberg*—G-5, No. 3, 11.

The biggest ship and the biggest dock—US-42, May 6, 11.

Some problems relating to the use of the internal combustion engine for marine propulsion—E-11, April 21, 11.

Notes on battleships—US-31, April, 11.

Battle cruisers—E-2, April 29, 11.

New warships and old—E-5, April 28, 11.

The most practical type of destroyer (from a German study)—F-12, April 22, 11.

England:

Progress of warships and machinery under construction in England—E-4, Jan. 13, 11.

Building of the new Canadian navy—E-4, Dec. 23, 10.

British battleship *Orion* (picture)—E-4, Jan. 6, 11.

British battleship *Colossus* (picture)—E-4, Jan. 6, 11.

The new naval yard at the Cape of Good Hope—E-5, Dec. 30, 10.

H. M. Battleship *Hercules*. (Photograph)—E-4, March 10, 11.

The airship for the British navy—E-5, Feb. 17, 11.

H. M. S. *Thunderer*—E-4, Feb. 3, 11.

Launch of H. M. S. *Thunderer*—E-11, Feb. 3, 11; E-5, Feb. 3, 11.

Our eleventh dreadnought. The *Neptune* (England)—E-19, Jan. 19, 11.

H. M. Battleship *Colossus* (with cuts)—E-5, April 7, 11; E-11, April 21, 11.

H. M. S. *Monarch*—E-4, April 21, 11; E-5, April 7, 11.

The English naval estimate for 1911-12—G-5, May, 11.
Launch of H. M. S. *Princess Royal*—E-11, May 5, 11.
Launch of H. M. Battleship *Conqueror*—E-4, May 5, 11.
Germany:
Retrospect of German naval program—G-5, Jan., 11.
The German battleship *Von der Tann* (picture)—E-4, Jan. 6, 11.
Austria:
The development of the Austrian fleet—G-5, No. 4, 11.
France:
Shipyard and shops at St. Nazaire—E-5, Dec. 23, 10.
The submersible, *Ampere*, (French) 450 tons—F-12, Dec. 17, 10.
New French dreadnought drydocks—E-4, Jan. 6, 11.
Trials of the *Voltaire*—F-12, Nov. 5, 10.
Turbines in the French navy—F-12, Oct. 29, 10.
Naval competitions (France)—F-12, Oct. 29, 10.
Trials of the *Voltaire*—F-12, Oct. 22, 29, 10.
The *Waldeck-Rousseau* (photo)—F-12, March 4, 11.
French battleships—E-4, Mar. 17, 11.
Italy:
Naval construction in Italy (1861-1911)—I-3, Jan., Feb., 11.
The truth concerning the battleship *Dante Alighieri*—A-1, No. 1, 11.
Russia:
The future of the Russian fleet—US-3, Feb. 11, 11.
Japan:
Launch of the Japanese battleship *Kawachi*—US-23a Mar.-April, 11.
Aki, the first Japanese dreadnought. Turbine engines drive the ship at 20.2 knots—US-42, April 8, 1.
Minor States:
The new Spanish fleet—A-3, Dec., 10.
The protected cruiser *Uruguay*—F-1, Feb. 25, 11.
The Argentine torpedo-boat destroyer—E-4, March 3, 11.
Argentine's ocean-going turbine destroyers—E-4, Jan. 20, 11.
United States:
Recent engine-room developments in the U.S. navy—US-15, Jan. 12, 11.
The Panama Canal and the navy—US-31, Dec., 10.
Data of battleship *Delaware's* trials—US-28, Dec., 10.
The American navy. Its material and its personnel—US-43L, Feb. 18, 11.
Experiments with guns *versus* armor (The *Katahdin*)—US-3, Feb. 18, 11.
The *Arkansas*, our latest battleship—US-42, Feb. 4, 11.
The raising of the *Maine*—F-1, April 29, 11.
The *San Marcos* experiments—US-31, April, 11.
The American naval defense—F-12, April 8, 11.

MISCELLANEOUS

The navy and the Hague conference—F-12, Dec. 31, 10.
The heavens in January—US-42, Jan. 7, 11.
The struggle for sea power—E-20, Jan., 11.
German military literature in 1910—G-4, Dec., 10.
Race prejudice in the Far East—US-30L, Dec., 10.
The most curious craft afloat (*The Carnegie*)—US-30L, March, 10.

The physiology of flight—US-43L, Dec. 17, 24, 10.
The heavens in December—US-42, Dec. 3, 10.
The Von Lobell reports on military matters in 1909—E-8, Dec., 10.
The heavens in November—US-42, Oct. 29, 10.
The fortification of the Panama Canal. A grave international question—E-8, Oct. 25, 10.
The German Emperor in Belgium—S-5, Oct. 30, 10.
The soldiers state of mind on the field of battle—S-5, Oct. 2, 10.
The formation of waves and the use of oil to calm the sea—F-12, Nov. 5, 10.
An American problem. The United States, Mexico and Japan?—F-0, Mar. 14, 11.
The new Alliance and the Scandinavian—Sc-2, Feb. 1, 11.
The Americans in Mexico—F-0, March 11, 11.
Psychology and military education—Sc-4, No. 1, 11.
The Krupp works. A series of illustrations—US-13, March, 11.
The struggle for sea power. The rise of the German navy—E-20, Feb., April, May, 11; E-19, Mar., 11.
Declaration of London—E-19, March, 11.
The abandonment of the two-power standard—E-19, March, 11.
Geographic influences in American slavery—US-4a, Feb., 11.
Canada, the U. S. and British imperial crisis—F-0, Feb. 25, 11.
China and Russia—F-0, Feb. 22, 11.
Our situation (France)—F-1b, Feb. 15, 11.
The heavens in February—US-42, Feb. 4, March 11, 11.
Prone pressure method of resuscitation from electric shock and drowning—US-9, Feb., 11.
The Von Löbell reports on military matters in 1909—E-8, Jan., 11.
Retrospect of army and navy, 1909—S-3, Oct., 10.
The Bristol Class III recording thermometer. A gas filled instrument with an automatic compensating device—US-17, Jan. 19, 11.
The neutrality of the Scheltd (Belgium)—S-5, April, 23, 11.
The heavens in April—US-42, April 1, 29, 11.
German railroads and the Belgian frontier—S-5, April 9, 11.
Arbitration and the limitation of armaments—F-0, April 3, 11.
China's movement westward and the problem of Turkestan—G-5, No. 4, 11.
Telegraphic communications of Germany with its colonies—G-6, April 1, 11.
The importance of naval supremacy—A-3, No. 2, 11.
Liquid fuel supply—US-8, May, 11.
Fuel resources of the United States—US-8, May, 11.
The Belgian view of the fortification of Flushing—E-10a, Jan.-Mar., 11.
The Declaration of London—E-10a, Jan.-Mar., 11.
Recent progress in the fixation of atmospheric nitrogen—US-11, April 27, 11.
Psychology of war—US-24, May, 11.
More on the selection of naval bases—US-23a, Mar.-April, 11.
Fortification or neutralization (of the Panama Canal)—US-23a, Mar.-April, 11.
Artificial respiration—US-23a, Mar.-April, 11.
The selection and defense of naval bases—US-23a, Jan.-Feb., 11.
Naval and military progress in 1910—US-23a, Jan.-Feb., 11.
Explosion gases and their effects on man—US-23a, Jan.-Feb., 11.

The Far East—E-9, April, 11.
The Panama Canal and its domestic and political significance—G-9, May, 11.
Contributions on military statistics—A-2, No. 5, 11.
The United States and Mexico—the American army—F-0, March 18, 11.
Armaments and arbitration—E-5, March 17, 11.
Modern expedients when searching a battlefield—G-6, Mar. 25, 11.
The Alaska boundary survey—US-15, April 27, 11.
The Balkan crisis, third letter of a "Young Turk"—F-0, April 15, 11.

[illegible]

GENERAL LIBRARY,
UNIV. OF MICH.
JUN 30 1911

CUMULATED SEMI-ANNUALLY

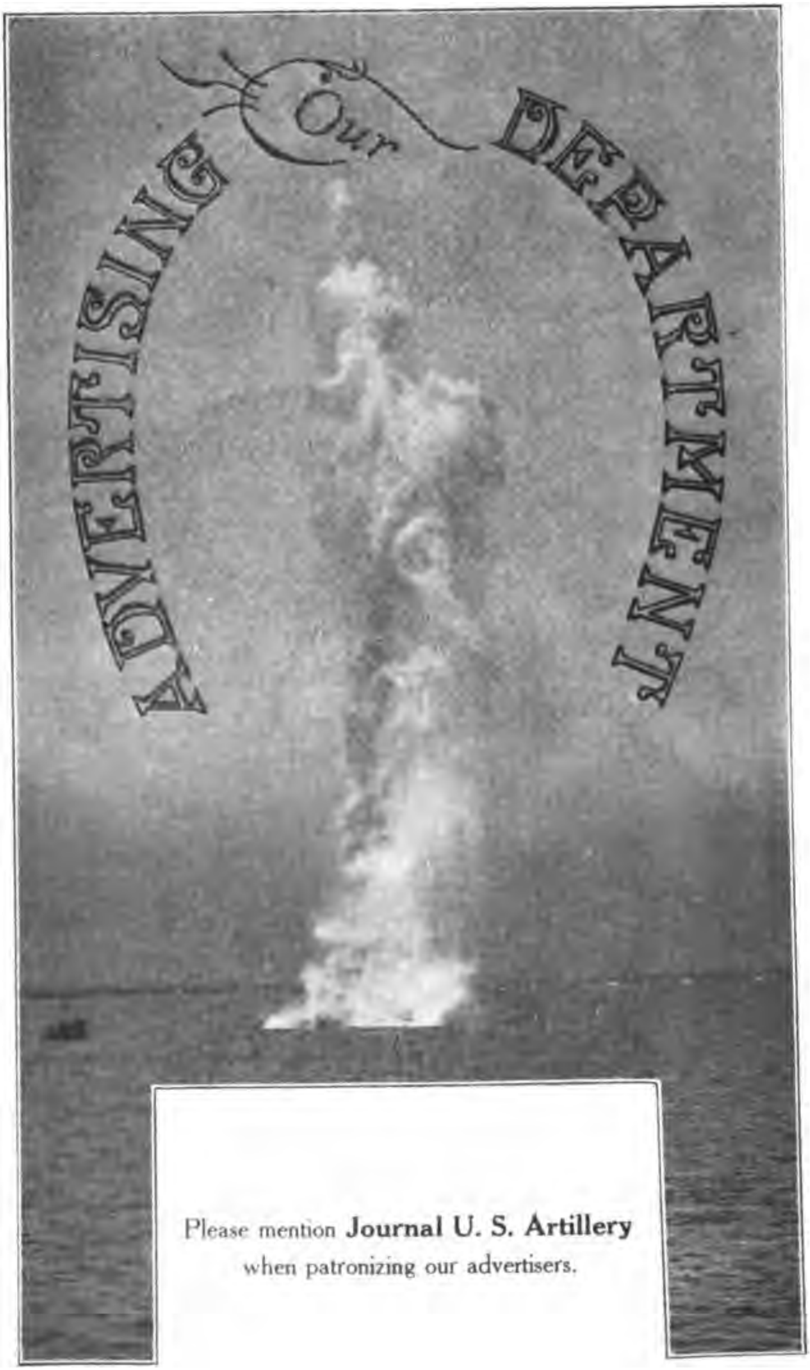
Index to Current Military Literature

PUBLISHED WITH THE

Journal U. S. Artillery

VOLUME 35
JANUARY TO JUNE, 1911
CUMULATED

Fort Monroe, Virginia
COAST ARTILLERY SCHOOL PRESS
1911



Please mention **Journal U. S. Artillery**
when patronizing our advertisers.

COLT **Automatic Pistol**

(CALIBER .45)

THE MOST POWERFUL AUTOMATIC PISTOL MADE

Capacity of magazine. 7 shots
Length of barrel. 5 inches.
Length all over. 8 inches.
Finish. Full blued. Checked. walnut stocks.
Weight. 33½ ounces.

Accidental Discharge is Absolutely Impossible with the Colt Automatic Pistol

CATALOG OF ALL COLT MODELS SENT ON REQUEST

REVOLVERS
AUTOMATIC GUNS
AUTOMATIC PISTOLS
GATLING GUNS

COLT'S PATENT FIRE ARMS MFG. CO.

HARTFORD, CONN., U. S. A.

FRANKEL & EISENMAN

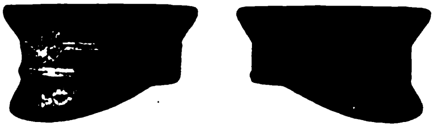
will appreciate if you'll give them a chance to prove to you—that we can tailor your clothes faultlessly and perfect fitting—and at the same time—will save you money.

Give us a trial on your next suit.

Suits to order—and every one guaranteed – from **$20.00 to $50.00.**

FRANKEL & EISENMAN
HAMPTON, VA. and PHOEBUS, VA.

CAPS



THE SUPERIOR QUALITY KIND THAT ALWAYS PLEASE

Guaranteed perfect. Praised by every officer who ever wore one. Strictly correct in every detail for all officers of every branch of the service.

Catalogue and price list free on request

THE HENDERSON-AMES CO.
KALAMAZOO, MICH.

MENTION THE JOURNAL

Your Stenographer will do **More Work** Every day with the

UNDERWOOD
STANDARD
TYPEWRITER

Because Visible writing as originated in the Underwood, entirely eliminates the wasted time and energy spent in lifting the carriage of a "blind" machine. It allows operator to keep the mind continually on the work —consequently there are fewer errors, greater accuracy and neater work.

Let us show you a few of the ecxlusive features and demonstrate to your entire satisfaction, the immeasurable superiority of

"The Machine You Will Eventually Buy"

THE UNDERWOOD TYPEWRITER COMPANY, Inc., Anywhere

Large Repairs Executed By Contract

We weld fly-wheels, gear. wheels, crankshafts, locomotive frames, stern posts and rudder frames of steamships, electric motor cases and all other broken wrought iron and steel sections. We can do the work anywhere as all our appliances are light and portable and may be BROUGHT TO THE JOB.

Estimates submitted on receipt of blue print or sketch giving full dimensions and showing exactly what is to be done. Pamphlet No. 20-Z illustrates over 30 big welding operations and will give you an idea of what we can do.

Goldschmidt Thermit Company, 90 West Street, New York
W. C. CUNTZ, General Manager.
432-436 Folsom St., San Francisco, Cal. 103 Richmond St., W. Toronto, Can.

MRS. C. M. TERRY

Florist

Fresh Cut Flowers

Floral and Wedding Designs at Short Notice

Store Phone 138 J Residence Phone 138 L
207 Mellen Street, Phoebus, Va.

Richardson Grocery Co.

Formerly RICHARDSON & BUSH

For

Table Delicacies

Agents Chase & Sanborn Boston Coffees

HAMPTON, VA.

Phones 5 and 95

Post Deliveries, Tues., Wed., Fri. and Sat.

W. A. PLEASANTS

Furniture, Stoves
AND
Housefurnishings

29 WEST QUEEN STREET
Phone 22 HAMPTON, VIRGINIA

Lee & Patterson Hdw. Co.

Visit us in our big New Store and inspect the best stock of high quality Sporting Goods and House Furnishings in this section.

15 E. Queen St., Hampton, Va.
Next to Richardson's Grocery

The
Hampton Steam Laundry
Wagons

Visit the Post Daily

High Grade Work

Phone or Postal

Phone 489 Office Office Hours, 9 a. m. to 5 p. m
Phone 255 Residence Saturdays, 9 to

Dr. Wm. H. Pearson
Dr. D. C. Colvin
Dentists

PYTHIAN CASTLE HAMPTON, VA.

Go to

James Grant

Dealer in

Hardware, Paints, Oils

House Paints a Specialty

Phone 559

20 and 21 Mellen St., Phoebus, Va.

FACTORIES:
RED BANK, N. J.
SOUTH AMBOY, N. J.

NEW YORK SALESROOMS
103 FIFTH AVENUE

Long Distance Telephones

SIGMUND EISNER

MANUFACTURER OF

CLOTHING UNIFORMS

RED BANK, N. J.

COMES OUT A RIBBON
LIES FLAT ON THE BRUSH

It is sound tactics to have sound teeth

To keep up general efficiency—appearance, comfort, health itself—you must have strong, clean, white teeth

COLGATE'S
RIBBON DENTAL CREAM
TRADE MARK

cleans the teeth delightfully and thoroughly. Destroys decay-germs and also by its lasting antiseptic action keeps the mouth in that sweet, clean, non-acid condition that counteracts germ growth.

CLEANS, PRESERVES, POLISHES DELICIOUSLY AND ANTISEPTICALLY

The flavor is so delicious that you'll enjoy Ribbon Dental Cream as you never have another dentifrice. No "druggy" taste but a sense of wholesome cleanliness.

Send 4c for a Trial Tube, 42 inches of Cream, enough for three weeks' use.

COLGATE & CO.,

199 Fulton Street, Dept. 49, New York.

GREATEST EASE OF OPERATION
and
EXCELLENCE OF WORK.

THE WRITING MACHINE OF
UNIVERSAL ADAPTABILITY.

35 Languages on One Instrument.
Instantly Interchangeable Type in Various Styles.
Perfect and Permanent Alignment.
Writes in Colors.
Absolute Visibility of Writing.

(WASHINGTON BRANCH)

THE HAMMOND TYPEWRITER COMPANY,
324 and 25 Colorado Building,
WASHINGTON, D. C.

H. L. SCHMELZ,
President

F. W. DARLING,
Vice-President

THE
BANK OF HAMPTON

HAMPTON, VA.

Located Near Fort Monroe, Va.

Capital and Surplus, $250,000.00
Resources, . . $1,650,000.00

THE OLDEST AND LARGEST BANK IN EITHER
HAMPTON OR NEWPORT NEWS, VA.

4 PER CENT. INTEREST PAID ON SAVINGS DEPOSITS

You can bank with us as easily by
mail as in person. Write to us about it.

SPECIAL ATTENTION GIVEN TO ARMY ACCOUNTS

NELSON S. GROOME,
Cashier.

WANTED—A RIDER AGENT IN EACH TOWN and district to ride and exhibit a sample Latest Model "Ranger" bicycle furnished by us. Our agents everywhere are making money fast. *Write for full particulars and special offer at once.*

NO MONEY REQUIRED until you receive and approve of your bicycle. We ship to anyone, anywhere in the U. S. *without a cent deposit* in advance, *prepay freight*, and allow **TEN DAYS' FREE TRIAL** during which time you may ride the bicycle and put it to any test you wish. If you are then not perfectly satisfied or do not wish to keep the bicycle ship it back to us at our expense and *you will not be out one cent.*

FACTORY PRICES We furnish the highest grade bicycles it is possible to make at one small profit above actual factory cost. You save $10 to $25 middlemen's profits by buying direct of us and have the manufacturer's guarantee behind your bicycle. **DO NOT BUY** a bicycle or a pair of tires from *anyone* at *any price* until you receive our catalogues and learn our unheard of *factory prices* and *remarkable special offers* to **rider agents.**

YOU WILL BE ASTONISHED when you receive our beautiful catalogue and study our superb models at the *wonderfully low prices* we can make you this year. We sell the highest grade bicycles for less money than any other factory. We are satisfied with $1.00 profit above factory cost. **BICYCLE DEALERS,** you can sell our bicycles under your own name plate at double our prices. Orders filled the day received.

SECOND HAND BICYCLES. We do not regularly handle second hand bicycles, but usually have a number on hand taken in trade by our Chicago retail stores. These we clear out promptly at prices ranging from **$3** to **$8** or **$10.** Descriptive bargain lists mailed free.

COASTER-BRAKES, single wheels, imported roller chains and pedals, parts, repairs and equipment of all kinds at *half the usual retail prices.*

$8.50 HEDGETHORN PUNCTURE-PROOF SELF-HEALING TIRES *A SAMPLE PAIR TO INTRODUCE, ONLY* **$4.80**

The regular retail price of these tires is $8.50 per pair, but to introduce we will sell you a sample pair for $4.80 (cash with order $4.55).

NO MORE TROUBLE FROM PUNCTURES

NAILS, Tacks or Glass will not let the air out. Sixty thousand pairs sold last year. Over two hundred thousand pairs now in use.

DESCRIPTION: Made in all sizes. It is lively and easy riding, very durable and lined inside with a special quality of rubber, which never becomes porous and which closes up small punctures without allowing the air to escape. We have hundreds of letters from satisfied customers stating that their tires have only been pumped up once or twice in a whole season. They weigh no more than an ordinary tire, the puncture resisting qualities being given by several layers of thin, specially prepared fabric on the tread. The regular price of these tires is $8.50 per pair, but for advertising purposes we are making a special factory price to the rider of only $4.80 per pair. All orders shipped same day letter is received. We ship C. O. D. on approval. You do not pay a cent until you have examined and found them strictly as represented.

Notice the thick rubber tread "A" and puncture strips "B" and "D," also rim strip "H" to prevent rim cutting. This tire will outlast any other make—SOFT, ELASTIC and EASY RIDING.

We will allow a **cash discount** of 5 per cent (thereby making the price $4.55 per pair) if you send **FULL CASH WITH ORDER** and enclose this advertisement. We will also send one nickel plated brass hand pump. Tires to be returned at **OUR** expense if for any reason they are not satisfactory on examination. We are perfectly reliable and money sent to us is as safe as in a bank. If you order a pair of these tires, you will find that they will ride easier, run faster, wear better, last longer and look finer than any tire you have ever used or seen at any price. We know that you will be so well pleased that when you want a bicycle you will give us your order. We want you to send us a trial order at once, hence this remarkable tire offer.

IF YOU NEED TIRES don't buy any kind at any price until you send for a pair of Hedgethorn Puncture-Proof tires on approval and trial at the special introductory price quoted above; or write for our big Tire and Sundry Catalogue which describes and quotes all makes and kinds of tires at about half the usual prices.

DO NOT WAIT but write us a postal today. **DO NOT THINK OF BUYING** a bicycle or a pair of tires from anyone until you know the new and wonderful offers we are making. It only costs a postal to learn everything. Write it **NOW.**

J. L. MEAD CYCLE COMPANY, CHICAGO, ILL.

Gunner's Instruction

1910-1911

UP-TO-DATE

ORDER NOW

JOURNAL U. S. ARTILLERY

BEFORE ordering MAGAZINES get our big clubbing catalogue and special offers and save MONEY.

SOUTHERN SUBSCRIPTION AGENCY

(A Postal Card will do.) **Raleigh, N. C.**

Common Interests — Mutual Benefit

Patronize our Advertisers and mention the JOURNAL when so doing.

The Service of Coast Artillery

BY FRANK T. HINES, UNITED STATES ARMY
Captain, Coast Artillery Corps, Honor Graduate, U. S. Coast Artillery School
AND
FRANKLIN W. WARD, NATIONAL GUARD OF NEW YORK
Major, C. A. C., 9th Artillery Dist., Member Examining Board for Artillery Officers

Large 8vo. 548 pages of text. Illustrated with 42 full-page half-tone plates and 92 other illustrations. Price $3.50 net.

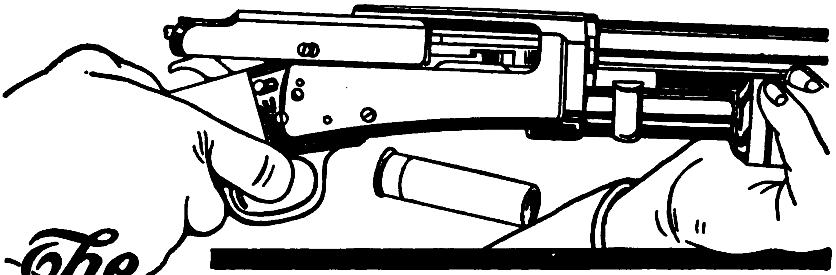
PUBLICATION AUTHORIZED BY THE WAR DEPARTMENT AND ADOPTED FOR THE USE OF THE ARMY AND ORGANIZED MILITIA OF THE UNITED STATES.

"It amounts to a technical dictionary and professional manual adapted to the needs of the entire Coast Artillery Service—commissioned officers and enlisted force, whether Regulars or Militia. Unquestionably the book belongs at the head of the military publications of the year."—*Army and Navy Journal.*

"It is not only a coast artillery text book of absolute completeness, but a military dictionary, phrase book, and technical glossary."—*Army and Navy Register.*

"It is really a monumental work, covering all branches of the broad field of modern coast artillery. We have no hesitation in recommending it to any one who is interested in the science of modern coast artillery, be he officer, or enlisted man, regular, or reserve."—*Journal of the U. S. Artillery.*

GOODENOUGH & WOGLOM COMPANY
122 NASSAU STREET, NEW YORK



The Marlin 12 GAUGE **Repeating Shotgun**

Made famous by its dependability. The solid top and side ejection keep gases and powder away from your eyes; help quick, effective repeat shots. Rain, sleet, snow and foreign matter can't get into the action.
The mechanism is strong, simple, wear-resisting. The double extractors pull any shell instantly; two special safety devices prevent accidental discharge while action is unlocked, and an automatic recoil block makes hang fires harmless. All Marlins are strongly made, finely balanced, accurate, hard hitting guns, and are the quickest and easiest to take down and clean. Illustration shows Model 24 grade "A" 12 gauge; it has all the features that make for a perfect gun.

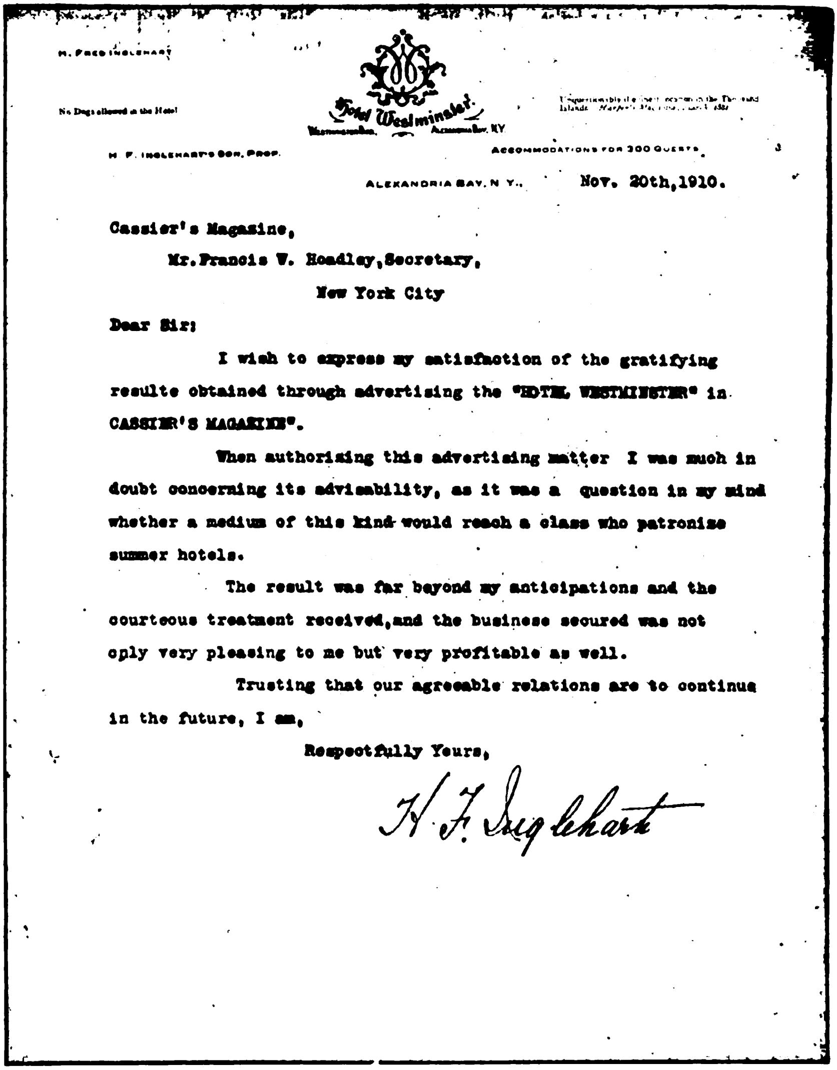
Send three stamps postage today for our 136 page catalog describing the full *Marlin* line.

The Marlin Firearms Co.
42 Willow Street New Haven, Conn.

A. Shuman & Co.
Boston
Shuman Corner

Army and Navy Tailors

Another Letter from "As Others See Us"



H. FRED INGLEHART

No Dogs allowed in the Hotel

Hotel Westminster

Alexandria Bay, N.Y.

H. F. INGLEHART'S SON, PROP.

ACCOMMODATIONS FOR 300 GUESTS.

ALEXANDRIA BAY, N. Y., Nov. 20th,1910.

Cassier's Magazine,
Mr.Francis V. Hoadley,Secretary,
New York City

Dear Sir:

I wish to express my satisfaction of the gratifying results obtained through advertising the "HOTEL WESTMINSTER" in CASSIER'S MAGAZINE".

When authorising this advertising matter I was much in doubt concerning its advisability, as it was a question in my mind whether a medium of this kind would reach a class who patronise summer hotels.

The result was far beyond my anticipations and the courteous treatment received,and the business secured was not only very pleasing to me but very profitable as well.

Trusting that our agreeable relations are to continue in the future, I am,

Respectfully Yours,

H. F. Inglehart

"THE RESULT FAR BEYOND MY EXPECTATIONS."

SEND FOR

"AS SOME OTHERS SEE US"

Sequal to "As Others See Us" SENT FREE ON REQUEST

Send for a Free Sample Copy of

CASSIERS MAGAZINE

And see why such Letters are Written or send $1.00 for a Trial Subscription for 6 months and these Sample Copies.

THE CASSIER MAGAZINE COMPANY, 12 West 31st Street, NEW YORK.

Armor and Ships

By John W. Gulick, U. S. Army

Captain, Coast Artillery Corps, Instructor, Coast Artillery School

Paper cover. 6¼" x 9¾". 135 pages of text. 97 illustrations. Price, 50 cents, postpaid.

Part I: Chapter I, Armor; Chapter II, Armor Attack.

Part II: Chapter I, Structural Features of Warships; Chapter II, Composition and Arrangement of Ships' Batteries; Chapter III, Armor Protection for Ships and Guns; Chapter IV, The Evolution of Battleships and Cruisers, Foreign Ships; Chapter V, Ship Studies, Attack Sheets, etc.

The edition of the Journal of the United States Artillery, for July-August, 1906, Whole No. 80, containing an article on Armor and Ships, having been exhausted and there being demand for additional copies, it was decided to prepare and issue a revised edition of the article in the form of a pamphlet in two parts; Part I dealing with Armor and Armor Attack, and Part II dealing with Warships, and Attack of Warships. The work has been completely revised. The original work has been used during the past four years in the Coast Artillery School and many of the changes and additions are the result of suggestions from Student Officers on duty at the School.

Journal of the U. S. Artillery

Fort Monroe, Va.

Don't Miss It—Saves You $65

Special Limited Offer to Journal U. S. Artillery Readers

Of 300 Latest

Model 8 American Typewriters

This special offer gives you a high-grade Typewriter at $35, the lowest price at which a standard machine has ever been sold, and on easy terms. The American will do the work of the $100 machines at high speed, and is covered with the same guarantee. It is their equal because it has every essential feature; 1200 cumbersome, troublesome and easily broken parts of other machines have been eliminated. Its simplicity of construction, the absence of the thousand and one little levers, bars, screws and springs which make the cost of $100 machines accounts for this unequaled offer. The absence of all these complicated parts makes the American tip the scales at 12 pounds. Its the only high-grade machine that is really portable. The fundamental point of American superiority is the single type-bar-one-piece of steel-non-bendable and unbreakable by any stroke that can be delivered on the key, and this is the cause of its simplicity, durability, efficiency and compactness.

Compare the Essential Features of the $100 Machine and the $50 American as noted below

The $100 Machine	The $50 American
Universal Keyboard	So Has the American
Print from Ribbon	So Does the American
Type Bar Machines	So Is the American
Adaptability for Rapid Work	Speed Unlimited on American
Various Degrees of Complicated Mechanism	1200 Less Parts on the American
High Quality of Work	Perfectly Aligned, Clear Cut Impression from American
Carriage Action on Some, Light; Others Cumbersome	Extremely Light, Ball-bearing Carriage on American
Portability Impossible When Convenience is Considered	Fewer Parts, Less Weight
Durability Varied	One-piece Bar, Less Complex, Longer Life
Two-Color Ribbon Shift only on Some	Two-Color Ribbon Shift
A few have Tabulating Indicator	Tabulating Indicator on Every American
Price $100	**Special Price, $35**

You have the choice of three styles of type: Large for public speakers, medium for business, elite for personal correspondence.

Each machine has rubber dust cover, oil, type brush and full directions for using. Handsome enameled metal case $2.50 extra, canvas traveling case $5 extra.

American Typewriter Co., 265 Broadway, N. Y.

Please have shipped to me for 5 days' free trial, one latest model American Typewriter offered in *Journal U. S. Artillery*, the regular price of which is $50. I authorize you to do this with the understanding that if I am not satisfied- if the machine is not satisfactory to me, I am to notify you within 5 days to that effect, and hold same subject to your order or deliver it to the express agent carefully packed as you may direct, or, if I decide to keep it, I am to pay $5 after 5 days and $5 per month until the full *special* price of $35 is paid, machine to remain your property until paid for.

Name

Address

Town State

References required

FIVE DAYS' FREE TRIAL Don't buy the American on our mere say so, fill out the attached coupon, and mail it to us at once. We will ship you an American F.O.B., N.Y. Use it in your office, give it the severest test you can, note its simplicity, the durability assured by the use of only the very finest materials throughout, its efficiency, its compactness, its superior finish and its high speed. If the machine is all we say and you are entirely satisfied, keep it, send us $5 as a first payment, not $35 all in one lump, the balance you can pay at $5 a month for six months. Don't delay, simply fill out and mail the coupon with references. The machine will answer all questions. Specify the style of type you wish and if you wish a hard platen for manifolding.

American Typewriter Company

265 Broadway, N. Y.

Incorporated 1893

NEW BOOKS AND REVISED EDITIONS

MANUAL FOR ASPIRANTS FOR COMMISSIONS IN THE UNITED STATES MILITARY SERVICE
By Capt. IRA L. REEVES, U. S. Army, Retired
Full Cloth, Price $1.00

BATTLE ORDERS
A Study in the Technique of Orders
By Capt. HANS von KIESLING, Ger. Gen'l Staff.
Translated by Capt. OLIVER L. SPAULDING, Jr. 5th Field Artillery
(Adopted as a Text-Book at the Army Service School, Ft. Leavenworth, Kans.)
Full Cloth, $1.50

DOCTOR ANTOMARCHI
The Last Physician to the
EMPEROR NAPOLEON THE FIRST AT ST. HELENA.
By Capt. H. D. THOMASON, Med. Corps, U. S. A.
Full Cloth, Illustrated, $1.00

UNDER THE RED AND GOLD; THE SIEGE OF BALER
Translated from the Spanish by Lieutenant-Colonel F. L. DODDS, U. S. A.
Full Cloth, $1.25

MANUAL OF PHYSICAL DRILL
By Lieut. E. B. GAREY, U. S. Army
The Army, Militia and other such organizations of this country are sadly in need of some system whereby the body can be kept in perfect physical condition by devoting a few minutes daily to the exercise of the body's organs and muscles.
Cloth, Fully Illustrated, Price, $1.00

ARMY ALTERATIONS
Edited by Captain JAMES A. MOSS, 24th Infantry
Giving all changes since publication in the Army Regulations, Manuals of the various Departments, Field Service Regulations, Manual of Guard Duty, the different Drill Regulations, etc.
Single Copies, 75c $2.00 a Year
Published Quarterly

FOURTH EDITION
Special Announcement to Troops Ordered for Service in the Philippines
ENGLISH-SPANISH MANUAL
By Maj. C. G. MORTON, Inspector-Gen'l, U. S. A.
Full Cloth, 16 mo, 108 pages, post-paid, $1.00
Special terms made when twelve or more copies are ordered at one time.

FRANKLIN HUDSON PUBLISHING COMPANY,
KANSAS CITY, MO.
SEND FOR COMPLETE LIST OF OUR PUBLICATIONS

POPE BICYCLES
COLUMBIA RAMBLER
CLEVELAND TRIBUNE

IN the POPE lines will be found a variety of styles, equipment and prices to meet every requirement. Both chain and chainless models are offered, so perfect their balance, so graceful their lines, and so accurate their adjustment that they have well earned their position of supremacy over all other machines.

RAMBLER $40.00 ROADSTER.

The 1911 catalogues are being printed and will explain, by cuts and descriptive matter, all the fine points of these bicycles. They tell how the materials are tested, describe the ingenious method of frame construction, illustrate the armour plate cones and cases and explain the superiority of the new Pope Spring Fork.
Catalogue will be sent upon request.

POPE BICYCLES
CAN BE PURCHASED AT
THE POST EXCHANGE.

THE POPE MANUFACTURING CO., HARTFORD, CONN.

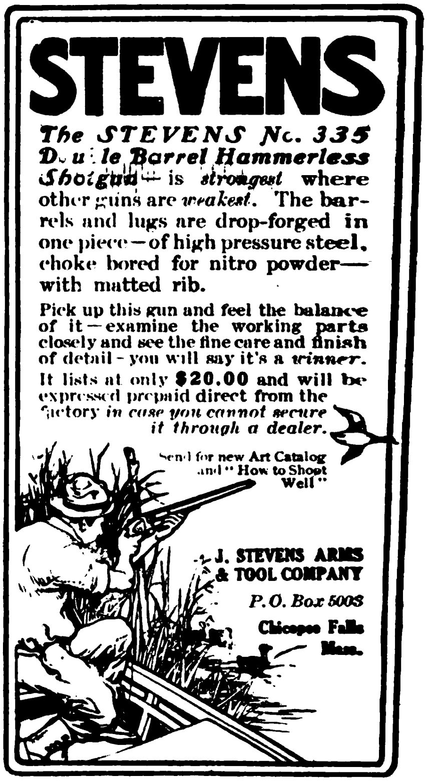
What It Means

We desire to solicit the aid of our friends to increase the number of our advertising patrons to as great an extent as possible.

We know our subscribers patronize our advertisers, but we want you to mention the **Journal U. S. Artillery** when you do so.

If you mention the Journal, you assist us to **retain** our advertisements, and, also, to **increase** this department.

Help us make the Journal larger and better.



STEVENS

The STEVENS No. 335 Double Barrel Hammerless Shotgun — is *strongest* where other guns are *weakest*. The barrels and lugs are drop-forged in one piece — of high pressure steel, choke bored for nitro powder — with matted rib.

Pick up this gun and feel the balance of it — examine the working parts closely and see the fine care and finish of detail - you will say it's a *winner*. It lists at only **$20.00** and will be expressed prepaid direct from the factory *in case you cannot secure it through a dealer.*

Send for new Art Catalog and "How to Shoot Well"

J. STEVENS ARMS & TOOL COMPANY
P. O. Box 5008
Chicopee Falls Mass.

WANTED

Copies of the

Journal U. S. Artillery

Issues of
July, 1892
March-April, 1896
Jan.-Feb., 1906
Jan.-Feb., 1908

We will pay 50 cents each for copies in good condition

Journal U. S. Artillery,
Fort Monroe, Va.

The Journal of the Royal Artillery

Published by the Committee of the

ROYAL ARTILLERY INSTITUTION, WOOLWICH

This Journal contains technical literature on all branches of the British Artillery, also notes, translations and precis from foreign journals on all points connected with artillery.

The Journal appears about the 10th of each month

Orders should be prepaid **Price 2s 6d**

60 YEARS' EXPERIENCE

PATENTS

TRADE MARKS
DESIGNS
COPYRIGHTS &C.

Anyone sending a sketch and description may quickly ascertain our opinion free whether an invention is probably patentable. Communications strictly confidential. HANDBOOK on Patents sent free. Oldest agency for securing patents.

Patents taken through Munn & Co. receive *special notice*, without charge, in the

Scientific American.

A handsomely illustrated weekly. Largest circulation of any scientific journal. Terms, $3 a year: four months, $1. Sold by all newsdealers.

MUNN & Co. 361 Broadway, **New York**
Branch Office, 625 F St., Washington, D. C.

DO IT

TODAY

TOMORROW

ALWAYS

Patronize, as far as is consistent with your interests, those firms who have advertisements in our **Journal.**

Call the attention of the members of your families to these advertisements and thus help us make as good a showing as possible to the people who pay for advertising space with us.

Mention the Journal when so doing.

Consult the Technical Index

A comprehensive descriptive record of the world's current technical literature. It indexes each month over 1,000 articles in French, German and English trade and technical journals. Dewey decimal system of classification. $2.50 per year; printed one side only for pasting on cards, $4.00. Clippings and translations supplied promptly and at reasonable rates.

Send 10 cents for sample copy

The GEO. H. GIBSON CO.,
American Representatives,
1119 Tribune Building, NEW YORK CITY.

THE ORIGINAL AND ONLY GENUINE

Horlick's Malted Milk

is pure, rich milk, combined with all the nutritive elements of choice malted barley and wheat in powder form. A delicious food-drink, more nourishing than tea or coffee, is ready in a moment by simply stirring in water, until dissolved. The tablet form, also, is a sustaining luncheon for those on an outing or traveling, and a wholesome substitute for sweetmeats for growing children. For convenience, nutrition and digestibility, it is an ideal food preparation, retained by the weakest stomach, therefore excellent in dyspepsia, debility and wasting diseases.

Ask for HORLICK'S, the original

Horlick's Malted Milk Co
RACINE, WISCONSIN

THE YEAR-ROUND RESORT OF AMERICA
OLD POINT COMFORT, VIRGINIA

HOTEL CHAMBERLIN

AT
FORTRESS
MONROE
The Largest
Military Post
on the
Atlantic Coast
ON
HAMPTON
ROADS

The Rendezvous of the Nation's Warships

With Climate Unequalled the Year Round

GOLF, TENNIS, MILITARY DRILLS, SAILING, NAVAL MANEUVERS

The Baths and Sea Pool at The Chamberlin

are the finest in America. The pool is so perfectly ventilated and radiant with sunlight that you are really bathing out-of-doors. Filtered sea-water is constantly flowing in, and the air and water are always at an agreeable temperature.

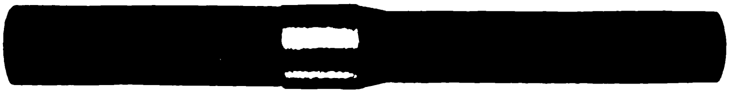
The Medicinal Department is Complete in Every Detail.

Nauheim Baths, Electric Cabinets, Massage and Tonic Baths of every description. A most unique feature is that we employ pure sea-water in many of them, thus adding to the medicinal value the very marked benefits derived from the salt of the sea. These are especially recommended for Insomnia, Nervousness, Rheumatism, Gout and kindred disorders. Special booklet on "Baths and Bathing" may be had by addressing as above.

Interesting Illustrated Booklets Free

Address GEO. F. ADAMS, Manager, Fortress Monroe, Va.

SAFETY



VEST POCKET SIZE, 3 3-4 INCHES

The Paul E. Wirt SAFETY CAP
Fountain Pen

Can not leak, no matter in what position or pocket it is carried. Made in long or short sizes. Prices $2.50 to $6.00

For further information, address Bloomsburg, Penn.

Gunners' Instruction

1910-1911

Gun and Mortar Companies

Seventh Edition

Mine Companies

Third Edition

Revised and enlarged editions. Better than ever. Gives all information necessary to qualify as Gunner in Coast Artillery.

January 31, 1911

Gun and Mortar Companies		*Mine Companies*	
Copies printed	**6,698**	**Copies printed**	**2,515**
Copies sold - -	**5,338**	**Copies sold - -**	**1,280**
Copies on hand	**1,360**	**Copies on hand**	**1,235**

Place Your Order Now

25c each **$5.00 for 25** **$7.50 for 50**

(Postpaid)

Send all Orders to

Journal U. S. Artillery

ARMY MUTUAL AID ASSOCIATION

Organized January 13, 1879

Total amount paid beneficiaries - $1,754,806.87
Emergency reserve - - - - - 317,567.77

An Association organized and managed by Officers for the benefit of Officers

NO PROFITS LIGHT EXPENSES

The following rates include expenses:

Rates per $1,000:— 21 - $13.25 31 - $17.08 41 - $23.18

Membership limited to Commissioned Officers of the Army. Apply to the Post or Transport Surgeon for application blank, or write to the Secretary.

504 COLORADO BUILDING WASHINGTON, D. C.

B. F. STEVENS & BROWN

American Library and Literary Agents

4 Trafalgar Square, Charing Cross,
LONDON, ENGLAND

Messrs. B. F. Stevens & Brown supply English and Continental Books (new and second hand) Magazines, etc., by mail or otherwise to any part of the world, or in their weekly shipments to their New York agents, at lowest London rates. They are agents for the principal United States Naval and Military Departments, Libraries and Schools, and are at any time glad to supply any information in their power.

Engravings, Drawings, and Paintings, Philosophical Apparatus, Scientific Instruments, and all other wants of libraries or offices receive due attention.

Payments must be made by Money Order or in Greenbacks and stamps at $5 to the £1 sterling, or to their New York Agents:

MESSRS. TICE & LYNCH, 16 Beaver Street, New York

BOOK DEPARTMENT

JOURNAL U. S. ARTILLERY

Write to the JOURNAL before
placing orders for your books.
We can save money for our
subscribers on **any book**
in any language.

WE WILL BUY ONE BOOK OR ANY NUMBER OF BOOKS FOR YOU

Prices furnished on application.

The SAVAGE Automatic Pistol

(Manufactured in 32 caliber only at the present time for the commercial trade)

SPECIAL features embodied in this arm which will appeal to *You:*

TEN SHOTS—Double the number in an ordinary revolver and two more than other automatics.

ACCURACY—The only automatic which locks at the breech while the bullet traverses the barrel, insuring extreme accuracy as well as freedom from fouling.

SIMPLICITY—Fewer parts than other automatics. Completely dismounts by hand without the aid of tools.

SAFETY—Breech automatically locked during time of discharge. Cannot be fired unless the trigger is pulled. Safety positively locks it against discharge.

CONVENIENCE—Length only 6½ inches; weighs but 19 ounces; full-blued finish.

Send for descriptive circular and booklet, "The Tenderfoot's Turn," by Bat Masterson, regarding this arm, which contains much interesting information.

Also Manufacturers of well known Savage High Power Repeating Rifles, calibers 303, 30-30, 25-35, 32-40 and 38-55, as well as 22 caliber Repeaters and Single Shots.

HANDSOME CATALOGUE SENT UPON REQUEST.

Savage Arms Company

122 Savage Avenue, - - - Utica, N. Y.